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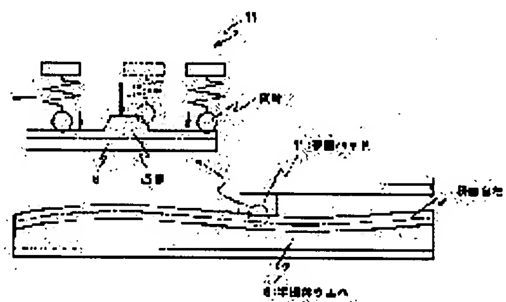
(54) POLISHING DEVICE, ABRASIVE MATERIAL AND POLISHING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To highly precisely planarize the surface of a semiconductor wafer and the like by displacing the respective parts of the polishing face of a abrasive material against a work face at prescribed reference speed or higher and displacing a polishing area at reference speed or lower on the work face.



SOLUTION: The polishing face of a polishing pad 11 is displaced at prescribed speed or more on the surface of the semiconductor wafer 6 in a state, where the semiconductor wafer 6 is rotated at comparatively low speed. The semiconductor wafer 6 is rotated at comparatively low speed and the polishing area is displaced at prescribed speed or below. Namely, the polishing pad 11 is displaced against the semiconductor wafer 6 and a projection part generates depression force for displacing the abrasive grains of the polishing pad 11, when the fine projection part appears on the surface of the semiconductor wafer 6. Thus, the surface of the semiconductor wafer 6 can be highly precisely planarized.

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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Concerning polish equipment, abrasives, and the polish approach, this invention can be applied, when carrying out flattening of the wafer front face in a semi-conductor production process. In case this invention carries out the sequential variation rate of the polish field on a processing side and grinds a processing side, it enables it to reduce markedly irregularity with the minute wafer front face by a circuit pattern etc. on a target in a polish field as compared with the former by carrying out the variation rate of each part of a polished surface to a processing side above a predetermined criteria rate, and carrying out the variation rate of the polish field below at a criteria rate to a processing side.
[0002]
[Description of the Prior Art] Conventionally, it is made as [form / on a semi-conductor wafer / with a sufficient precision / detailed structure] by carrying out flattening of the front face of a semi-conductor wafer in a semi-conductor production process if needed.
[0003] That is, in a semi-conductor production process, as shown in drawing 38 , after forming circuit pattern 2 grade on the semi-conductor wafer W which passed through various down stream processing, the insulating layer 3 by the oxide film is deposited. Flattening of the front face of this insulating layer 3 is carried out with polish equipment, and it enables it to expose a desired pattern with a sufficient precision in a semi-conductor production process in exposure processes, such as a circuit pattern which continues by this.
[0004] Drawing 39 is the perspective view showing the outline configuration of this polish equipment. This polish equipment 5 is in the condition which held the semi-conductor wafer W on the predetermined table T, and carried out the rotation drive, for example, it presses rotating scouring pad P on the front face of the semi-conductor wafer W, supplying a slurry. Scouring pad P presses the front face of the semi-conductor wafer W according to extent of this deformation, and is made as [carry out / by this / flattening of the front face of the semi-conductor wafer W] while deforming following irregularity with the detailed front face in the semi-conductor wafer W, as it is formed with a comparatively flexible resin ingredient and this shows drawing 40 .
[0005]
[Problem(s) to be Solved by the Invention] By the way, since it is necessary to improve the precision of the exposure with which creation of this circuit pattern etc. is presented in order to form a circuit pattern etc. minutely further much more, grinding the front face of a semi-conductor wafer evenly further much more is called for. Moreover, also when enlarging the diameter of a wafer of a semi-conductor wafer, grinding the front face of a semi-conductor wafer evenly further much more similarly is called for.
[0006] When extent of polish was verified from such a thing, it turned out that display flatness with a high precision of extent for which the semi-conductor manufacture after 0.25[mum] generation is asked depending on the polish technique in conventional polish equipment is not securable.
[0007] This invention was made in consideration of the above point, and tends to propose the polish

equipment, the abrasives, and the polish approach of carrying out flattening of the front faces, such as a semi-conductor wafer, with a high precision.
[0008]
[Means for Solving the Problem] In order to solve this technical problem, in the polish field to which the polished surface of abrasives comes to contact the processing side for processing in this invention, the variation rate of each part of a polished surface is carried out to a processing side above a predetermined criteria rate, and the variation rate of the polish field is carried out below at a criteria rate on a processing side.
[0009] It is made for a criteria rate to become at the rate corresponding to the resonance frequency of the base of the mechanical transmission function of the between abrasives and for processing at this time. By setting up the displacement rate of a polished surface so that the frequency of the stress which the heights or the crevice of a processing side gives to a polished surface may become more than this resonance frequency The variation rate of the polish field is carried out below at a criteria rate by carrying out the variation rate of each part of a polished surface to a processing side above a criteria rate, and setting up a displacement rate so that the frequency of the stress which the wave of a processing side gives to a polished surface may turn into below this resonance frequency.
[0010] Where a rotation drive is carried out with a predetermined revolving shaft, it is partially pressed by the processing side for processing to rotate, and in the abrasives which grind said processing side, a degree of hardness is set up so that the basic resonance frequency of the mechanical transmission function to the candidate for processing may turn into a frequency of 10 times or more of the rotational frequency for processing.
[0011] Moreover, bonded abrasive carries out distributed mixing and forms in the resin which has a detailed hole at this time.
[0012] if the variation rate of each part of a polished surface is carried out to a processing side in a polish field above a predetermined criteria rate -- a setup of this criteria rate -- in this polish field, it can grind efficiently about detailed heights by how. moreover -- if the variation rate of the polish field is carried out below at a criteria rate on a processing side -- the same -- a setup of a criteria rate -- to the wave in a processing side, the whole can be ground along with this wave by how. Detailed irregularity can be ground by this and flattening of the processing side can be carried out.
[0013] If more nearly technical limitation is added, it will be made for a criteria rate to become at the rate corresponding to the resonance frequency of the base of the mechanical transmission function of the between abrasives and for processing. By setting up the displacement rate of a polished surface so that the frequency of the stress which the heights or the crevice of a processing side gives to a polished surface may become more than this resonance frequency If the variation rate of each part of a polished surface is carried out to a processing side above a predetermined criteria rate, each part of a polished surface will displace with the phase contrast of about 180 degrees to the stress by this heights or crevice. That is, heights etc. will be pressed and ground so that it may displace to hard flow with the displacement direction with this stress, and it can grind positively so that heights may decrease. Moreover, if the frequency of the stress which the wave of a processing side gives to a polished surface carries out the variation rate of the polish field below at a criteria rate by setting up a displacement rate so that it may become below this resonance frequency, it will grind only by the thrust by the elastic deformation of the polish member corresponding to this wave, and can form the processing side which met the wave mostly.
[0014] In the abrasives which are partially pressed by the processing side for processing to rotate, and grind this processing side by the same principle where a rotation drive is carried out with a predetermined revolving shaft If a degree of hardness is set up so that the basic resonance frequency of the mechanical transmission function to the candidate for processing may turn into a frequency of 10 times or more of the rotational frequency for processing Even if it carries out polish processing at the rate with which practical use is presented by setup of the displacement rate of a polish field etc., it can have sufficient allowances, and the candidate for processing can be ground so that flattening of the detailed irregularity may be carried out.

[0015] Moreover, if distributed mixing of the bonded abrasive is carried out and abrasives are formed in the resin which has a detailed hole at this time, it is used combining with a loose grain, and the fall of a polish rate can be avoided effectively and can be ground efficiently.
[0016]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained in full detail, referring to a drawing suitably.
[0017] (1) Polish principle drawing 2 of the gestalt of operation is the approximate line Fig. showing the fundamental configuration of the polish equipment concerning the gestalt of operation of this invention. In the gestalt of this operation, polish equipment 10 is in the condition of having rotated the semi-conductor wafer 6 with the low speed comparatively, and presses the scouring pad 11 which is high-speed and rotates to the semi-conductor wafer 6. A scouring pad 11 is formed in the shape of a ring here so that the semi-conductor wafer 6 may be contacted in the field which estranged only predetermined distance from the revolving shaft to radial (the field where this scouring pad 11 contacts on the semi-conductor wafer 6 below is called a polish field).
[0018] Thereby with polish equipment 10, the variation rate of the polished surface of a scouring pad 11 is carried out to the front face of the semi-conductor wafer 6 in a polish field above a predetermined rate. Moreover, by rotating the semi-conductor wafer 6 with a low speed comparatively, on the semi-conductor wafer 6, it is below a predetermined rate and the variation rate of this polish field is carried out.
[0019] Furthermore, a scouring pad 11 makes the resin which becomes with binding material distribute an abrasive grain, is formed, and it is formed so that it may have the predetermined elasticity corresponding to the rotational speed of a scouring pad 11, and the displacement rate of a polish field. Thereby with polish equipment 10, it is made as [carry out / markedly / as compared with the former / to a target / flattening of the front face of a semi-conductor wafer].
[0020] That is, if the variation rate of the scouring pad 11 is carried out to the semi-conductor wafer 6 and minute heights appear in the front face of the semi-conductor wafer 6 at this time as shown in drawing 1 , these heights will generate the thrust to which the variation rate of the abrasive grain of a scouring pad 11 is carried out. If an abrasive grain displaces promptly to this thrust, a scouring pad 11 will grind heights only according to the elastic force of the resin which changes with these variation rates.
[0021] The variation rate of such an abrasive grain is based on the elastic deformation by binding material, and such elastic deformation is accompanied by the predetermined time lag to impression of external force. This time lag is expressed with a phase function, and if conditions are set up so that the phase lag of about 180 degrees may be produced to the external force generated by heights, in an abrasive grain, heights will be pressed and ground so that it may displace to the sense and hard flow of this thrust to the thrust by heights. That is, by carrying out the variation rate of the polished surface of a scouring pad 11 to the front face of the semi-conductor wafer 6 above a predetermined linear velocity, the height of heights can be markedly reduced efficiently on a target as compared with the former.
[0022] On the other hand, in the semi-conductor wafer 6, if conditions are set up to the variation rate of the abrasive grain by this wave so that the phase change by the time lag may become small when the front face winds greatly, the variation rate of the abrasive grain can be carried out along with the wave of this front face, and the whole can be ground along with the wave of this front face. That is, along with the wave of the front face of the semi-conductor wafer 6, the whole can be ground by rotating the semi-conductor wafer 6 with a low speed comparatively, being below a predetermined rate and carrying out the variation rate of this polish field on the semi-conductor wafer 6.
[0023] Such a time lag can be judged with the mechanical transmission function between a scouring pad 11 and a wafer 6. This detected the mechanical transmission function **** amplitude characteristic as shown in drawing 3 by arranging the source of excitation to a scouring pad 11 side, arranging pickup to a wafer 6 side in the gestalt of this operation, and detecting propagation of vibration emitted from the source of excitation by pickup (drawing 3 (A)). In the frequency more than resonance frequency, as for such the amplitude characteristic, a phase characteristic will change about 180 degrees. The frequency

this analyzes this amplitude characteristic and according to the wave of the front face of the semi-conductor wafer 6 is the basic resonance frequency f0. The frequency according to heights with the minute front face of the semi-conductor wafer 6 so that it may become below is this basic resonance frequency f0. Conditions were set up so that it might become above.

[0024] That is, in the semi-conductor wafer 6, since 1-2 big heights by such wave are formed, if rotational speed of the semi-conductor wafer 6 is set to N [Hz], the frequency by this wave will become about 2N at the maximum. Thereby at the gestalt of this operation, it is the basic resonance frequency f0. The frequency by the wave of the semi-conductor wafer 6 even if it sets up the elasticity of a scouring pad 11 so that it may become 200 [Hz] extent, and it carries out the rotation drive of the scouring pad 11 at high speed is the basic resonance frequency f0. It sets up so that it may become below. Moreover, it is the basic resonance frequency f0 about the frequency according to the minute heights on the semi-conductor wafer 6 by the rotational speed of a scouring pad 11. It sets up above. It sets up so that it may become a frequency with the frequency still higher enough by heights about a scouring pad 11, and a polish rate is improved.

[0025] In addition, this basic resonance frequency f0 It changes with wear of a scouring pad 11, thrust, extent of contact, etc. Moreover, the polish rate of the semi-conductor wafer 6 changes with the rotational frequencies of the semi-conductor wafer 6 a lot so that it may mention later. Therefore, it is the basic resonance frequency f0 to the frequencies 0.5-1 [Hz] with the gestalt of this operation, set the rotational speed of the semi-conductor wafer 6 as 30 [r/min] (0.5 [Hz]), and according to the wave of the semi-conductor wafer 6. It is set as 200 or more times. even if the conditions of polish boil many things and change by this -- basic resonance frequency f0 It enables it to grind the semi-conductor wafer 6, maintaining the relation of the frequency by the wave of the semi-conductor wafer 6 to receive with sufficient allowances. according to the result in which it experimented -- the rotational frequency of the semi-conductor wafer 6 -- receiving -- basic resonance frequency f0 When setting it as about 10 or more times, even if polish conditions boiled many things and changed, it turned out that a front face is ground along with the wave of the semi-conductor wafer 6, and flattening of the irregularity with a detailed front face can be carried out, and it can grind to extent with which this presents practical use.

[0026] (2) The configuration (2-1) basic block diagram 4 of the gestalt of the 1st operation is a perspective view showing the polish equipment concerning the gestalt of the 1st operation. In a semi-conductor production process, after this polish equipment 10 receives supply of the semi-conductor wafer 6 by the wafer cassette 12 and grinds the front face of this semi-conductor wafer 6, it is contained to the same wafer cassette 12, and is supplied to degree process.

[0027] The processing section 13 is formed so that it may project in the center of a near side from a back side with a drawing, this polish equipment 10 sandwiches the lobe of this processing section 13 in between, and the load buffer 14 and the unload buffer 15 are formed in right and left, respectively. Furthermore, the wafer conveyance device 16 is formed in the upper part of these load buffer 14 and the unload buffer 15, and the wafer washing brush 17 is arranged at the discharge side of the unload buffer 15.

[0028] According to the conveyance device in which are the buffer area made to stand by temporarily, and the semi-conductor wafer 6 supplied to the processing section 13 is not illustrated, from the wafer cassette 12, the load buffer 14 picking-takes out the non-ground semi-conductor wafer 6 one by one, and holds it here. The unload buffer 15 contains the semi-conductor wafer 6 to the wafer cassette 12 according to the conveyance device in which are the buffer area made to stand by temporarily, and the semi-conductor wafer 6 which polish processing completed by the processing section 13 is not illustrated. The wafer washing brush 17 washes the semi-conductor wafer 6 conveyed by the wafer cassette 12 from the unload buffer 15.

[0029] The wafer conveyance device 16 holds the loader chuck 19 and the unloader chuck 20, interlocks, operates this loader chuck 19 and the unloader chuck 20, and conveys the semi-conductor wafer 6. That is, after adsorbing the load buffer 14 and the semi-conductor wafer 6 of the processing section 13 by the loader chuck 19 and the unloader chuck 20, respectively and evacuating upwards, respectively the wafer conveyance device 16 carries out movable [of each semi-conductor wafer 6] to

the processing section 13 and the upper part of the unload buffer 15, moves it to them caudad, and cancels adsorption of the semi-conductor wafer 6. Thereby, with polish equipment 10, after supplying the non-ground semi-conductor wafer 6 to the load buffer 14 and carrying out polish processing of this semi-conductor wafer 6 by the processing section 13, it is made as [discharge / from the unload buffer 15 / to the wafer cassette 12].

[0030] The processing section 13 receives supply of the semi-conductor wafer 6 by the loader chuck 19 through opening 13A, and grinds the front face of this semi-conductor wafer 6. Columns 22L and 22R are arranged at back side right and left, and, as for the processing section 13, the Z-axis guides 23L and 23R are formed in the front-face side of these columns 22L and 22R here. Furthermore, the semi-conductor wafer 6 which the processing section 13 was guided with these Z-axis guides 23L and 23R, it has been arranged so that the Z-axis slider 24 can carry out movable in the vertical direction, and the scouring pad has been arranged at this Z-axis slider 24, and was supplied from opening 13A to this scouring pad is conveyed on an X-axis table.

[0031] That is, drawing 5 is the top view and side elevation showing the processing section 13. In this processing section 13, in the lower part of opening 13A, if it stands by that the semi-conductor wafer 6 is laid and the semi-conductor wafer 6 is laid, the X-axis table 26 will carry out adsorption maintenance of this semi-conductor wafer 6, and will convey it to a predetermined polish location so that an arrow head A may show. If X shaft orientations are made to go and come back to the semi-conductor wafer 6 furthermore so that an arrow head B may show where the rotation drive of the semi-conductor wafer 6 is carried out with a predetermined rotational speed in this polish location and polish is completed, rotation of the semi-conductor wafer 6 will be suspended and it will convey to the lower part of opening 13A.

[0032] for this reason, the X-axis table 26 is constituted so that it can move to X shaft orientations along with the rail which is not illustrated -- having -- comparatively -- a low speed -- it is made as [carry out / with a motor / **** /, a pulley, or a belt / a rotation drive]. Moreover, it is constituted by the discoid of a diameter 200 [about] [mm] by the porosity member, and the X-axis table 26 is the thing corresponding to sufficient diameter of the semi-conductor wafer 6 to carry out the rotation drive of the semi-conductor wafer 6, and grind from the upper part done for vacuum suction through the predetermined path for vacuum suction, and adsorbs the semi-conductor wafer 6, for example.

[0033] The predetermined criteria attachment component 28 is arranged so that the processing section 13 may straddle Columns 22L and 22R. The Z-axis servo motor 29 is arranged and the processing section 13 makes this criteria attachment component 28 go up and down a scouring pad 11 to the semi-conductor wafer 6 arranged in the polish location by the drive of this Z-axis servo motor 29.

[0034] That is, the Z-axis servo motor 29 is arranged so that a revolving shaft may become Z shaft orientations, and a ball screw 32 is connected to the revolving shaft through coupling 31. This ball screw 32 is thrust into the subslider 33, and the subslider 33 is guided with the subslider guides 33L and 33R formed in the both-sides side, and is held free movable at Z shaft orientations. Thereby, the subslider 33 is driven with the Z-axis servo motor 29, and it is made as [fluctuate / to Z shaft orientations] so that an arrow head C may show.

[0035] One pair of load cells 35L and 35R are arranged, and, as for the subslider 33, the Z-axis slider 24 is connected to a tip side through these load cells 35L and 35R. This Z-axis slider 24 is guided with the Z-axis guides 23L and 23R formed in the front-face side of Columns 22L and 22R, and is formed in Z shaft orientations free movable. Thereby, the Z-axis slider 24 is driven with the Z-axis servo motor 29, and is made as [fluctuate / with the subslider 33 / to Z shaft orientations], and is made as [detect / through load cells 35L and 35R / a load].

[0036] As furthermore shown in drawing 6 , Wires 37L and 37R are connected to top-face right and left of the Z-axis slider 24, respectively, and it is made as [hang / through a pulley 38 / by the other end of these wires 37L and 37R / a balance weight 39]. Thereby, the Z-axis slider 24 mitigates the load which is formed so that it can drive up and down with the small Z-axis servo motor 29, and joins load cells 35L and 35R in the range detectable [with these load cells 35L and 35R].

[0037] Furthermore, the Z-axis slider 24 holds the main shaft spindle 40, and, as for this main shaft spindle 40, a scouring pad 11 is arranged at a revolving shaft. In the condition of actual processing that,

as for this Z-axis slider 24, the load by which the main shaft spindle 40 and scouring pad 11 grade are attached, and join load cells 35L and 35R with a balance weight 39 further was mitigated It is formed so that a center of gravity may be located on the center-of-rotation shaft O of the main shaft spindle 40, and it is formed so that the point of application P to these center-of-rotation shaft O and load cells 35L and 35R may be located on the same flat surface. Furthermore, this flat surface is formed in the front face of the semi-conductor wafer 6 in a polish location so that an abbreviation rectangular cross may be carried out. Thereby, the Z-axis slider 24 is made as [detect / the thrust by the scouring pad 11 / by load cells 35L and 35R / correctly], when a scouring pad 11 is pressed to the semi-conductor wafer 6.
[0038] Thereby, if the semi-conductor wafer 6 is arranged on the X-axis table 26 in a predetermined polish location, the processing section 13 is in the condition which carried out the rotation drive of the scouring pad 11 with the main shaft spindle 40, it drops the main shaft spindle 40 with the Z-axis servo motor 29, presses a scouring pad 11 to the semi-conductor wafer 6, and is made as [grind / the front face of the semi-conductor wafer 6]. Moreover, thrust is supervised by load cells 35L and 35R at this time, and it is made as [make / the semi-conductor wafer 6 / reciprocate to X shaft orientations on the X-axis table 26 further].
[0039] Drawing 7 is the sectional view showing the installation section of a scouring pad 11, and drawing 8 is the bottom view seen from the scouring pad side. In addition, in this drawing 7 , a publication is omitted about an adjustment device whenever [tilt-angle / which is mentioned later]. The main shaft spindle 40 has the main shaft housing 43 surrounding the perimeter of the main shaft 42 which becomes with a revolving shaft, and this main shaft 42, and attachment immobilization of the surface plate 41 is carried out at the lower part of a main shaft 42.
[0040] A nozzle hole 44 is formed so that the main shaft spindle 40 may extend even a surface plate 41 from a main shaft 42, and the nozzle tubing 45 is arranged in this nozzle hole 44. As for the main shaft spindle 40, the slurry as polish liquid is supplied to a scouring pad 11 with this nozzle tubing 45.
[0041] A surface plate 41 holds a scouring pad 11 by adhesion etc. on the inferior surface of tongue by the side of the semi-conductor wafer 6. Furthermore, as for a surface plate 41, slot 46A is formed in a bottom end face at a radial. Furthermore, as for a surface plate 41, the end plate 47 for slurry distribution is arranged at the connection of slot 46A and a nozzle hole 44. Thereby, in case a surface plate 41 supplies a slurry to a scouring pad 11 according to the centrifugal force by rotation, it avoids the bias of the amount of supply effectively by slot 46A of an end plate 47 and a radial. In addition, a slurry is separately supplied also to the periphery side of a scouring pad 11 by the predetermined nozzle.
[0042] The radial width of face d is formed by 20 [mm] again of 200 [mm] with an outer diameter D equal [a scouring pad 11] to the appearance of the semi-conductor wafer 6. Thereby, a scouring pad 11 forms an above-mentioned polish field on the semi-conductor wafer 6, and is made as [displace / to the front face of the semi-conductor wafer 6, / in this polish field, / are more than the predetermined rate with all the above-mentioned polished surfaces, and].
[0043] Furthermore, a scouring pad 11 is CeO2 based on urethane resin and melamine resin. It is made as [form / predetermined comes out to this base comparatively, and / the abrasive grain to twist carries out distributed mixing, and is formed, / a detailed hole]. The scouring pad 11 is made as [select / the compounding ratio of resin etc.] so that the elastic modulus mentioned above when it did in this way and was formed may be obtained. The surface hardness of a scouring pad 11 is held by incidentally being set up in this way at a value high enough as compared with the surface hardness of a firing polyurethane system scouring pad.
[0044] Furthermore, porosity is set as 37.4 [%] and, as for a scouring pad 11, the particle size of an abrasive grain is set as about 3.5 [mum].
[0045] On the other hand, a slurry is CeO2 as a filler. The water solution with which 24.5 [Wt%] distribution mixing of the abrasive grain to twist was carried out is used. To the abrasive grain particle size of a scouring pad 11, particle size can present practical use with a filler suitably in 1 / 6 - 1/3, and it is made as [select / particle size / by 0.5 [mum]] with the gestalt of this operation here.
[0046] Thereby, as contrast with drawing 1 shows to drawing 9 , in addition to the bonded abrasive held to the scouring pad 11, a scouring pad 11 grinds the semi-conductor wafer 6 with the loose grain

supplied by the slurry, and its polish capacity improves. Moreover, a scouring pad 11 misses polish or ** of the semi-conductor wafer 6 with the abrasive grain of a scouring pad 11 by lubrication being carried out by the slurry in a hole to the bonded abrasive and the pan which were omitted with polish while grinding the front face of the semi-conductor wafer 6 with the loose grain again, and, thereby, avoids the fall of polish capacity effectively. Moreover, with a loose grain, the blinding of the hole by polish, **, etc. missed to the hole in this way is prevented, and the fall of polish capacity is effectively avoided also by this.

[0047] Drawing 10 is the characteristic curve sheet showing the result of having actually ground the semi-conductor wafer for a test. It is CeO2 as the polish rate and sign L3 which were ground only with the scouring pad 11 so that a sign L1 might show, and the polish rate and sign L2 which supplied the slurry and were ground with the scouring pad 11 might show show this polish. It replaces with the abrasive grain to twist and is SiO2. The polish rate ground only with the scouring pad by the abrasive grain to twist was measured. According to this measurement result, it turns out that a semi-conductor wafer can be ground with sufficient polish rate.

[0048] Moreover, drawing 11 is the characteristic curve sheet showing change of the polish rate at the time of repeating and grinding a semi-conductor wafer. In this measurement, each semi-conductor wafer was ground about 120 [mum] every. According to this measurement result, it turns out that it turns out that a slurry is used together and change of a polish rate can be held to a value small enough, it applies to a semi-conductor production process, and can apply to mass production.

[0049] Drawing 12 is the sectional view showing the cross section of the semi-conductor wafer for a test used for the judgment of flattening by this polish equipment 10. This semi-conductor wafer for a test formed the pattern of 100 [mum] width of face at 0.4 [mum] spacing, and formed the pattern of 0.4 [mum] width of face at 2 [mm] spacing, and formed the insulator layer of silicon oxide from on this pattern. In measurement, the level difference (A-B) of this part and part where thickness is the thinnest projected most was measured on the front face of a semi-conductor wafer on the basis of the amount of polishes of the part which comes to project most (it becomes in the amount of reduction of thickness shown with Sign A).

[0050] If the thickness shown with Sign A does 120 [mum] reduction of this level difference before polish initiation when only the heights of a semi-conductor wafer are able to be ground ideally by this, those with 120 [mum], and, this level difference will become a value 0. Drawing 13 is the characteristic curve sheet showing this measurement result, and was able to check that did 120 [mum] polishes of and the residue of a level difference became below 200 [nm] with this polish equipment 10. Incidentally, when this semi-conductor wafer for a test was ground with conventional polish equipment, it turned out that a level difference will not fall in 500-700 [nm], and or more 1/3 flattening of the front face of a semi-conductor wafer can be carried out as compared with the former by this. In addition, in these measurement, thickness was measured by the optical technique using laser light, and the amount of polishes etc. was measured.

[0051] Drawing 14 is the sectional view and top view showing the relation between a scouring pad 11 and the semi-conductor wafer 6. If semi-conductor wafer 6 side face makes it a flat surface, a scouring pad 11 will form a polish field in an approximate circle arc configuration on the front face of the semi-conductor wafer 6 with the relation mentioned above, and will grind the front face of the semi-conductor wafer 6 in this polish field.

[0052] As shown in drawing 15 at this time, when an X-axis table reciprocates, with the gestalt of this operation, it changes with rotations of the semi-conductor wafer 6 again at the rate which the polish field carried out slowly. In the gestalt of this operation, the passing speed of the X-axis table 26 is set as the range of 60-140 (mm/min), and the range of 200 [mm] is set as the range of a reciprocating motion. In addition, as shown below at drawing 15 (A), the outermost periphery of a scouring pad 11 makes the location of X shaft orientations which started contact on the front face to the semi-conductor wafer 6 the location of X= 0 [mm], and as shown in drawing 15 (C), the outermost periphery of a scouring pad 11 makes the location moved to the center of rotation of the semi-conductor wafer 6 the location of X= 200 [mm].

[0053] Furthermore, in the gestalt of this operation, the rotation drive of the scouring pad 11 is carried out by the rotational speed Np of 300 [r/min], and the rotation drive of the semi-conductor wafer 6 is carried out by the rotational speed Nw of 30 [r/min].
[0054] (2-2) Adjustment device drawing 16 is the front view showing the maintenance device of the main shaft spindle 40 whenever [tilt-angle / of a main shaft]. The main shaft spindle 40 is held through the main shaft mounting eye 49 at the Z-axis slider 24, and, more nearly thereby than the Z-axis servo motor 29, carries out movable to Z shaft orientations with the Z-axis slider 24. Furthermore, the main shaft spindle 40 is made as [adjust / whenever / tilt-angle / of a main shaft / in the minute include-angle range / according to an adjustment device / the inclination of a center-of-rotation shaft], and, thereby, is made with polish equipment 10 as [set / as the optimal polish conditions / it / this inclination is adjusted if needed and].
[0055] That is, the main shaft spindle 40 is fixed to the main shaft mounting eye 49 through the main shaft flange 48 and taper rings 50 and 51. Taper rings 50 and 51 are formed in the shape of a ring, and the laminating of them is carried out to the main shaft mounting eye 49, they are arranged, and the main shaft flange 48 is arranged here in the upper part. Furthermore, it is pressed by the main shaft mounting eye 49 by the main shaft flange 48, and taper rings 50 and 51 are held so that it may be mostly arranged in the shape of the same axle to the revolving shaft of the main shaft spindle 40, a center-of-rotation shaft may be mostly set as this revolving shaft and it may rotate. it writes -- in carrying out, the main shaft spindle 40 will be fixed to the main shaft mounting eye 49 through the main shaft flange 48, and taper rings 50 and 51 will be arranged free [rotation] between this main shaft flange 48.
[0056] Furthermore, when it sees from a longitudinal direction, taper rings 50 and 51 are created so that the contact surface may form the taper sides 50a and 51a to which it inclined aslant to the medial axis. As this shows drawing 17 , the main shaft spindle 40 rotates taper rings 50 and 51, and is made as [lean / in the various directions / the center-of-rotation shaft O of a main shaft].
[0057] Taper rings 50 and 51 are formed so that the thickness seen from the longitudinal direction according to these taper sides 50a and 51a may do 5 [mum] change of at the maximum, and thereby, they are made with the gestalt of this operation here as [adjust / in the minute include-angle range / this center-of-rotation shaft O]. Moreover, even if it is formed so that the center-of-rotation shaft O of a main shaft can be leaned only about the direction in alignment with the X-axis, and this leans the center-of-rotation shaft O, the point of application P to these center-of-rotation shaft O and load cells 35L and 35R is held on the same flat surface, and it is made as [avoid / the fall of the detection precision by load cells 35L and 35R / effectively].
[0058] In addition, since taper rings 50 and 51 touch in respect of [50a and 51a] a mutual taper, even if it makes taper rings 50 and 51 intervene in polish equipment 10, the fall of machine rigidity between the main shaft spindle 40 and the main shaft mounting eye 49 is effectively avoidable. Thereby, with polish equipment 10, the fall of the natural frequency of the mechanical system between the main shaft spindle 40 and the main shaft mounting eye 49 is avoided effectively, and it is made as [carry out / the high-speed rotation of the main shaft 42].
[0059] Drawing 18 , drawing 19 , and drawing 20 are drawings showing the relation of the scouring pad 11 and the semi-conductor wafer 6 by the inclination of such a center-of-rotation shaft O. that is, in a scouring pad 11, the configuration by elastic deformation changes with thrust F according to the inclination of the center-of-rotation shaft O, and the polish area size formed on the semi-conductor wafer 6 boils many things, and changes. That is, when an inclination is large, a polish field forms small area, and if an inclination becomes large, a polish field will increase. Thereby, with the gestalt of this operation, an inclination is selected suitably, polish area size is adjusted, and it is made as [grind / it / according to the optimal conditions].
[0060] that is, the mechanical transmission function between the scouring pad 11 mentioned above and the semi-conductor wafer 6 only changes with the diameters of a wafer of not only the elasticity of a scouring pad 11 but the semi-conductor wafer 6 etc., is boiled variously and changes also with the area of a polish field. Therefore, it can incline and adjustment of theta can adjust finely conditions required in order to grind the minute heights of the semi-conductor wafer 6 alternatively.

[0061] Furthermore, this polish area size can also affect greatly the polish time amount which polish of one semi-conductor wafer 6 takes, and, thereby, can also adjust finely the amount of polishes per unit time amount. Moreover, distribution of a slurry can also be equalized by this adjustment and, thereby, fluctuation of a polish rate can be reduced.
[0062] In addition, when it does in this way and only the minute include angle theta leans a center-of-rotation shaft, in a scouring pad 11, the facing according to this inclination is needed.
[0063] (2-3) As drawing 5 was explained in the gestalt of this operation in the bias amendment device of the polishing pressure force, and time, by having made the X-axis table 26 reciprocate [as opposed to / only / a scouring pad 11], distribution of the thrust in a polish field will change according to the location of the X-axis table 26 by holding the point of application P to the center-of-rotation shaft O and load cells 35L and 35R on the same flat surface.
[0064] That is, when a scouring pad 11 and the semi-conductor wafers 6 overlap completely noting that the center-of-rotation shaft O is not leaned as shown in drawing 21 (drawing 21 (A) and (B)), in a polish field, a scouring pad 11 will press the semi-conductor wafer 6 according to uniform pressure distribution. However, if the X-axis table 26 displaces to the near side of polish equipment 10 as shown in drawing 22 and drawing 23 , when the part polish field displaces from the center-of-rotation shaft O to a near side, pressure distribution will ununiformity-ize.
[0065] In this case, when a scouring pad 11 is pressed by as high thrust as the periphery side of the semi-conductor wafer 6 near the center-of-rotation shaft O, as compared with other parts, a polish rate will increase in these parts. To uneven distribution of thrust which inclines toward a such center-of-rotation shaft O side, from the center-of-rotation shaft O, the semi-conductor wafer 6 will incline toward a near side, and will reciprocate. In this having left this, the amount of polishes serves as an ununiformity in each part of the semi-conductor wafer 6 with the ununiformity of this thrust.
[0066] In this case, as shown in drawing 24 , if the deadweight 54 which becomes the near side of the X-axis which becomes in the reciprocating motion direction of the semi-conductor wafer 6, for example, the upper part of the main shaft spindle 40, with weight is arranged, distribution of the thrust which inclined toward a such center-of-rotation shaft O side can be biased toward a near side from the center-of-rotation shaft O so that it may correspond to the reciprocating motion of the semi-conductor wafer 6 which inclined toward the near side from the center-of-rotation shaft O (drawing 24 (A) and (D)).
[0067] Moreover, distribution of the thrust which inclined toward a such center-of-rotation shaft O side so that it might correspond to the reciprocating motion of the semi-conductor wafer 6 which inclined toward the near side from the center-of-rotation shaft O when holding deadweight 54 from the upper part of the main shaft spindle 40 by the arm to the near side similarly, as shown in drawing 24 (B) can be biased toward a near side from the center-of-rotation shaft O (drawing 24 (B) and (D)). Moreover, even if it makes it bias the maintenance location of the main shaft spindle 40 by the Z-axis slider 24 toward a near side from the center-of-rotation shaft O, distribution of thrust can be similarly biased toward a near side from the center-of-rotation shaft O (drawing 24 (C) and (D)).
It is made as [adjust / the arrangement location of this deadweight 54 / with the inclination of the main shaft which mentioned polish equipment 10 above in the gestalt of this operation in carrying out to write / suitably], this adjusts the bias of thrust suitably if needed, and it is made as [grind / it / according to suitable conditions].
[0068] (2-4) As shown in speed-control drawing 25 (A) of an X-axis table, when the semi-conductor wafer 6 and scouring pads 11 overlap completely, in polish equipment 10, only the circumference part of the semi-conductor wafer 6 will be ground. Moreover, in a periphery side, a polish rate increases according to the linear velocity of a scouring pad 11 being as high as the periphery side of the semi-conductor wafer 6 to the semi-conductor wafer 6 at this time.
[0069] On the other hand, as shown in drawing 25 (B), after the X-axis table has done 100 [mm] displacement of, in the range of the core of the semi-conductor wafer 6 to the radius**20 [mm], there are many amounts of polishes and the amount of polishes of other parts becomes less than the condition of drawing 25 (A). Both-way migration of the X-axis table is only carried out by uniform velocity by this, and a scouring pad 11 is pressed by fixed thrust, and it becomes difficult in having carried out the

rotation drive of the semi-conductor wafer 6 and the scouring pad 11 at the fixed rate further to grind the whole surface of the semi-conductor wafer 6 to homogeneity.

[0070] If the rotational frequency of Np and the semi-conductor wafer 6 is set for the rotational frequency of a scouring pad 11 with Nw here and the linear velocity of the predetermined location in the scouring pad 11 and the semi-conductor wafer 6 corresponding to these rotational speed Np and Nw is set with **** and Vw, as shown in drawing 26 , in the predetermined location P of a polish field, vector composition of linear velocity **** and Vw can express the relative velocity Vx between a scouring pad 11 and the semi-conductor wafer 6.

[0071] A degree type can express amount [of the time amount t at the time of holding an X-axis table in a predetermined location] of polishes H (x) using this relative velocity Vx. In addition, Kp is a proportionality constant and Px here. It is the polishing pressure force.

[0072]

[Equation 1]

$$H(x) = Kp \cdot Px \cdot Vx \cdot t \quad \cdots\cdots (1)$$

[0073] Moreover, polishing pressure force Px It is expressed with a degree type. In addition, F shows the thrust of the whole by the scouring pad 11, and A is the area of the polish field where a scouring pad 11 and the semi-conductor wafer 6 come to contact.

[0074]

[Equation 2]

$$Px = F/A \quad \cdots\cdots (2)$$

[0075] It turns out that relative velocity Vx is changed by control of rotational speed Np and Nw by this, and time amount t is changed by control of the thrust F of a scouring pad 11, and the passing speed of an X-axis table, and the amount of polishes in each part of the semi-conductor wafer 6 can be controlled.

[0076] Drawing 27 is the characteristic curve sheet showing the count result of amount [at the time of carrying out both-way migration of the X-axis table by uniform velocity, and holding and grinding several Np rotation of the polishing pressure force Px and a scouring pad 11 and the rotational frequency Nw of the semi-conductor wafer 6 from this relational expression, to constant value] of polishes H (x). Drawing 27 (A) is the case where the successive range (traverse range) of the semi-conductor wafer 6 is set to 108 [mm] from X axial seat label location 1 [mm], and drawing 27 (B) is the case where this traverse range is set to 68 [mm] to 191 [mm]. It turns out that the amount of polishes differs in any case to the radius of the semi-conductor wafer 6.

[0077] On the other hand, from the relational expression of (1) type and (2) types, the result of having calculated the movable range of an X-axis table so that dispersion in the amount of polishes might become below a predetermined value to the radius of a break and the semi-conductor wafer 6 per 10 [mm] is shown in Table 1. In addition, the rotational speed of the semi-conductor wafer 6 and a scouring pad 11 was set as the same conditions as drawing 27 here.

[0078]

[Table 1]

研磨パッド ：2000〔r／min〕 半導体ウェハ： 20〔r／min〕	
X座標位置〔mm〕	研磨時間レート (基準値に対する送り速度の逆数の倍率)
0−10	2．3
10−20	2．4
20−30	3．74
30−40	2．
40−60	1．39
60−80	1．77
80−100	1．8
100−120	1．27
120−140	0．79
140−160	0．8
160−180	0．77
180−200	0

[0079] Drawing 28 is the characteristic curve sheet showing the count result of the amount distribution of polishes by the conditions of this table 1, and is understood that the homogeneity of the amount of polishes improves by leaps and bounds compared with distribution of the amount of polishes shown in drawing 27 .
[0080] In the gestalt of this operation, in actual polish, as mentioned above, the rotational speed of 30 [r/min] and a scouring pad 11 was set as 300 [r/min] for the rotational speed of the semi-conductor wafer 6, the polish field was adjusted, and the feed rate of an X-axis table was selected. Drawing 29 (A) is the characteristic curve sheet showing dispersion in the amount of polishes at the time of moving an X-axis table by uniform velocity, and drawing 29 (B) is the case where it carries out, 20 [%] reduction about the feed rate of (it is the case where an X-axis location is more than 150 [mm]), and an X-axis table, when grinding only a periphery side from a radius 50 [about] [mm]. According to this measurement result, when an X-axis table was moved by uniform velocity, what expressed dispersion with standard deviation delta and had dispersion in 11.7 [%] was able to be reduced to 4.3 [%]. In addition, this measurement is as a result of measurement of 51st of 100 semi-conductor wafers ground continuously (n= 51), and the 61st (n= 61) sheet.
[0081] Drawing 30 is the result of measuring dispersion in the amount of polishes using a semi-conductor 8 inches wafer top. In this case, it is as a result of measurement of the 1st of 100 sheets ground continuously (n= 1), and the 50th (n= 50) sheet, and is the amount of polishes of 49 points spirally set up on the semi-conductor wafer. This drawing 30 also shows that flattening of the semi-conductor wafer can be carried out. Moreover, drawing 31 is the result of measuring dispersion by the standard deviation delta using the point of measurement of 49 points which carried out in this way and was set up about 100 continuous semi-conductor wafers. In addition, an axis of ordinate is normalized with the average of standard deviation, and is shown. According to the property by this drawing 31 , it turns out that even polish of about 100 sheets can be ground evenly.
[0082] (2-5) Control drawing 32 of polish equipment is the block diagram showing the control system of polish equipment 10. The control system of this polish equipment 10 is constituted by the main control unit 60 of a computer configuration, and the driver which drives various motors with the control signal outputted by this main control unit 60.
[0083] The main shaft driver 61 carries out the rotation drive of the main shaft spindle 40 with the control signal outputted from a main control unit 60. At this time, the main shaft driver 61 carries out the rotation drive of the main shaft spindle 40 with the constant speed according to a control signal by forming the feedback loop and changing the load current following the load effect of the main shaft spindle 40. Furthermore, the main shaft driver 61 carries out current potential transform processing of this load current, generates the load detecting signal of the main shaft spindle 40, and outputs this load

detecting signal S1 to a main control unit 60. Thereby, the main shaft driver 61 is made as [detect / in a main control unit 60 / a load effect].
[0084] The Z-axis driver 62 carries out the rotation drive of the Z-axis servo motor 29 with the control signal outputted from a main control unit 60, and carries out movable [of the scouring pad 11] up and down by this, and presses it to the semi-conductor wafer 6.
[0085] The table shaft driver 63 carries out the rotation drive of the table shaft servo motor 69 (drawing 33) arranged at the X-axis table 26 with the control signal outputted from a main control unit 60, and, thereby, carries out the rotation drive of the semi-conductor wafer 6 with a predetermined rotational speed.
[0086] The X-axis driver 64 carries out the rotation drive of the X-axis servo motor 65 with the control signal outputted from a main control unit 60, and moves the X-axis table 26. The X-axis servo motor 65 is made here as [thrust / into the member by which the ball screw 66 was attached in the revolving shaft, and this ball screw 66 was attached in the X-axis table 26]. Thereby, the X-axis driver 64 rotates a ball screw 66, and moves the X-axis table 26.
[0087] A control panel 68 receives actuation of polish equipment 30 by the operator.
[0088] Drawing 33 is the block diagram showing the control system of this polish equipment 30 centering on a main control unit. A main control unit 60 controls actuation of this polish equipment 30 whole by performing procedure which secured the work area to random access memory (RAM) 80, and was recorded on external storage 81 and a read-only memory 84 by the central-process unit 82.
[0089] That is, if the wafer cassette 12 is arranged and a control panel 68 is operated, the central-process unit 82 will detect actuation of an operator through the predetermined interface (I/F) 83, and will drive the wafer conveyance device 16. If the semi-conductor wafer 6 is furthermore set to the X-axis table 26 by the drive of this wafer conveyance device 16, a control signal will be outputted to each drivers 61-64 through the digital-to-analog conversion circuits (D/A) 85-86, and the processing section 13 will be driven.
[0090] In the drive of this processing section 13, after the central-process unit 82 drives the X-axis table 26 and moves the semi-conductor wafer 6 to a polish location, it carries out the rotation drive of the semi-conductor wafer 6, and carries out the rotation drive of the scouring pad 11. If furthermore press a scouring pad 11 to the semi-conductor wafer 6, the semi-conductor wafer 6 is made to reciprocate and only the specified quantity grinds the semi-conductor wafer 6, a scouring pad 11 will be evacuated and the semi-conductor wafer 6 will be discharged.
[0091] In the case of this polish, through the analog-to-digital-conversion circuits (A/D) 89 and 90, the central-process unit 82 carries out the monitor of the load effect of the main shaft spindle 40, and the detection result S2 of the thrust by load cells 35R and 35L, and drives main shaft spindle 40 grade according to certain conditions.
[0092] Drawing 34 is the functional block diagram of the central-process unit 82 showing feed-rate control of the X-axis table 26. The central-process unit 82 receives the location detecting signal S3 of the X-axis table 26 from the circumference configuration of the X-axis servo motor 65, is changed into location detection data by the analog-to-digital-conversion circuit which does not illustrate this location detecting signal S3, and inputs it. The central-process unit 82 detects the location of the semi-conductor wafer 6 to a scouring pad 11 from this location detection data by wafer location conversion section 82A. Furthermore in X-axis rate command setting section 82B, the speed-control data which correspond from the location detection result by this wafer location conversion section 82A are generated, and the control signal by this speed-control data is outputted to the X-axis driver 64. In addition, this speed-control data is set up in advance through a control panel 68.
[0093] Thereby, the central-process unit 82 controls the passing speed of the X-axis table 26, as drawing 29 was explained.
[0094] Drawing 35 is the functional block diagram of the central-process unit 82 showing the control configuration of the thrust F of a scouring pad 11. The central-process unit 82 performs this control of a series of on the basis of the detection result S2 obtained from load cells 35R and 35L by actuation of an operator on the basis of the load detecting signal S1 obtained through the main shaft driver 61 (drawing

32).
[0095] That is, the central-process unit 82 computes the thrust F of a scouring pad 11 in thrust calculation section 82C from the load detecting signal S1 or the detection result S2. Furthermore, in continuing polishing pressure force calculation section 82D, the central-process unit 82 carries out division process of the thrust F computed by thrust calculation section 82C in the area of a polish field, and, thereby, calculates the thrust per unit area of a scouring pad 11.
[0096] The central-process unit 82 receives the thrust set up in advance from polishing pressure force setting section 82E, and detects the error value between the thrust computed by polishing pressure force calculation section 82D in subtraction section 82F continuing. Movement magnitude transducer 82G output control data, and drive the Z-axis servo motor 29 so that it may be completed as a value 0 by this error value. Thereby, the central-process unit 82 presses a scouring pad 11, and grinds the semi-conductor wafer 6 so that the thrust per unit area may become constant value.
[0097] (3) In the configuration beyond actuation of the gestalt of the 1st operation, with polish equipment 10, (drawing 4) and the non-ground semi-conductor wafer 6 are contained by the wafer cassette 12, and this wafer cassette 12 is arranged at the load buffer 14 side. Moreover, the empty wafer cassette 12 is arranged at the unload buffer 15 side.
[0098] If an operator operates a control panel in this condition and actuation of polish equipment 10 is started, from the wafer cassette 12, the semi-conductor wafer 6 will be set to the load buffer 14, this semi-conductor wafer 6 will be conveyed by the processing section 13 according to the conveyance device 16, and it will be ground in this processing section 13. Moreover, the processing section's 13 conveyance of the semi-conductor wafer 6 sets the continuing semi-conductor wafer 6 to the load buffer 14 from the wafer cassette 12. If polish is furthermore completed, while the semi-conductor wafer 6 will be conveyed by the unload buffer 15 from the processing section 13, the continuing candidate for polish is conveyed by the processing section 13.
[0099] Thus, with polish equipment 10, in case the semi-conductor wafer 6 contained by the wafer cassette 12 is ground in the sequential processing section 13, if the X-axis table 26 stands by under (drawing 5) and opening 13A and the semi-conductor wafer 6 is laid in this X-axis table 26, the X-axis table 26 will carry out movable, and the semi-conductor wafer 6 will be moved to a polish location. Furthermore, at this time, rotation of the semi-conductor wafer 6 is started, and the X-axis table 26 carries the semi-conductor wafer 6, and reciprocates in a polish location.
[0100] In the upper part of a polish location, if a scouring pad 11 stands by and the semi-conductor wafer 6 moves to a polish location, after this scouring pad 11 starts rotation, this scouring pad 11 will descend by the drive of the Z-axis servo motor 29, and the front face of the semi-conductor wafer 6 will be pressed. Thereby, with polish equipment 10, the rotating scouring pad 11 contacts the front face of the semi-conductor wafer 6, a polish field is formed, and the minute heights on the semi-conductor wafer 6 are ground by rotation of a scouring pad 11 in this polish field.
[0101] In this polish, to the basic resonance frequency of the mechanical transmission function between a scouring pad 11 and the semi-conductor wafer 6 (drawing 1 - drawing 3), the rotation drive of the polish equipment 10 is carried out by high speed (300 [r/min]) so that the frequency by the heights of the semi-conductor wafer 6 may turn into a high frequency. Moreover, a scouring pad 11 is formed in the shape of a ring, and relation with the frequency by the heights of the semi-conductor wafer 6 is maintained in all the fields of a polish field. To these minute heights, a scouring pad 11 presses heights so that an abrasive grain may displace against the thrust by these heights, and thereby, it grinds these heights positively.
[0102] Moreover, by rotation and a reciprocating motion of the semi-conductor wafer 6, this polish field displaces on the semi-conductor wafer 6 gradually, and, thereby, positive polish of these heights is performed on the whole front face of the semi-conductor wafer 6. By being set up so that the frequency by the wave of the semi-conductor wafer 6 may become lower enough than the basic resonance frequency of the mechanical transmission function of a scouring pad 11, to the wave of this semi-conductor wafer 6, elastic deformation is carried out along with this wave, and the front face of the semi-conductor wafer 6 is ground to homogeneity in a scouring pad 11 in the rotational speed of the

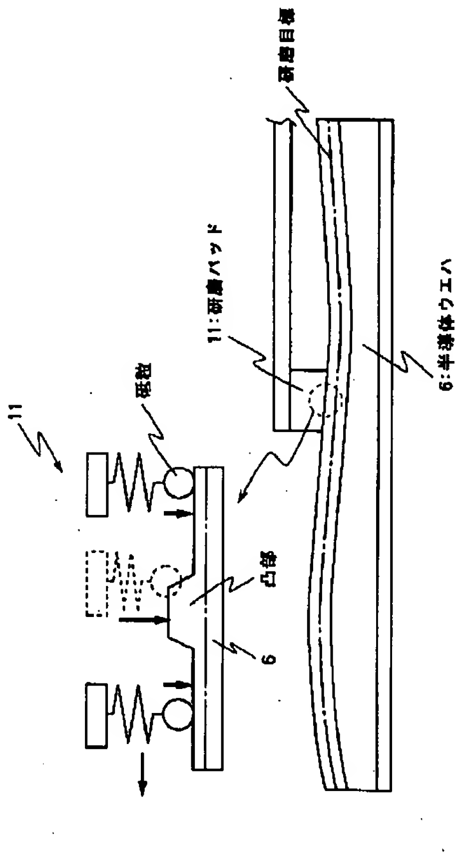
semi-conductor wafer 6 by relation with the elasticity (degree of hardness) of a scouring pad 11 at this time.
[0103] Thereby with this polish equipment 10, the big wave formed in the front face of the semi-conductor wafer 6 carries out flattening of the detailed irregularity, maintaining (drawing 13).
[0104] At this time, to the bonded abrasive contained in a scouring pad 11, the loose grain with which particle size was set as the range of 1 / 6 - 1/3 is supplied by the slurry, thereby, the lubrication of the polish field is carried out and it grinds the front face of the semi-conductor wafer 6 efficiently with bonded abrasive and a loose grain with polish equipment 10.
[0105] Moreover, even when the front face of the semi-conductor wafer 6 is ground as polish or ** of the bonded abrasive which dropped out at this time, and the semi-conductor wafer 6 escapes to the hole formed in the scouring pad 11, and the blinding of such a hole is prevented by the loose grain and this grinds a 100 number semi-conductor wafer continuously, these semi-conductors wafer 6 is ground by the original polish capacity.
[0106] Thus, in grinding the semi-conductor wafer 6, with polish equipment 10, if it is formed so that the center-of-rotation shaft O of the main shaft spindle 40 which carries out a rotation drive can lean a scouring pad 11 the degree of minute angle by adjustment of taper rings 50 and 51, and this center-of-rotation shaft O is leaned, that part scouring pad 11 will also incline to the semi-conductor wafer 6, and it will contact. With polish equipment 10, corresponding to the inclination of this center-of-rotation shaft O, facing of the scouring pad 11 is carried out, a scouring pad 11 will be pressed and the polish area size which comes to contact the semi-conductor wafer 6 will change according to this inclination (drawing 16 -20).
[0107] thereby, with polish equipment 10, this inclination is selected appropriately and it is made as [change / about polish area size, / it / many things are boiled and].
[0108] moreover -- polish equipment 10 -- load cells 35L and 35R -- or while the monitor of the thrust to the semi-conductor wafer 6 is carried out by the load effect of the main shaft spindle 40, the thrust per unit area is maintained by the predetermined set point by control of the Z-axis servo motor 29, and the rotation drive of the scouring pad 11 is carried out by the main shaft spindle 40. At this time, the semi-conductor wafer 6 is in the condition by which the rotation drive was carried out with a predetermined rotational speed, inclines toward a near side from the center-of-rotation shaft of a scouring pad 11 on the X-axis table 26, and reciprocates.
[0109] With polish equipment 10, the bias of the thrust by the partial reciprocating motion is amended by arranging deadweight 54 at the near side of the main shaft spindle 40 so that it may correspond to this partial reciprocating motion (drawing 21 - drawing 24).
[0110] Moreover, the feed rate of the X-axis table in this reciprocating motion is controlled according to the location of a polish field, and, thereby, the semi-conductor wafer 6 is evenly ground by the amount of polishes with the fixed whole.
[0111] (4) According to the configuration beyond the effectiveness of the 1st operation, press the ring-like scouring pad 11 to a semi-conductor wafer, form a polish field, and set to this polish field. By rotating a scouring pad so that it may become more than the basic resonance frequency of the mechanical transmission function whose frequency by the detailed heights of a semi-conductor wafer is between a scouring pad 11 and the semi-conductor wafer 6 To the displacement direction by these detailed heights, heights can be pressed and ground so that it may displace to hard flow, and thereby, the flatness of the front face of the semi-conductor wafer 6 can be carried out to this. Moreover, along with the wave of the semi-conductor wafer 6, it can grind as the semi-conductor wafer 6 whole by carrying out the variation rate of the polish field so that the frequency by the wave of the semi-conductor wafer 6 may turn into a frequency lower enough than basic resonance frequency. The front face of a semi-conductor wafer can be ground with a high precision by these.
[0112] Moreover, a semi-conductor wafer can be efficiently ground by having selected the particle size of this loose grain further in the range of 1 / 6 - 1/3 of bonded abrasive by grinding a semi-conductor wafer with the bonded abrasive of a scouring pad, and the loose grain by the slurry at this time.
[0113] By forming the still more detailed hole to this scouring pad, the fall of the polish capacity by the

bonded abrasive which dropped out is effectively avoidable.
[0114] The whole surface of the semi-conductor wafer 6 can be ground to homogeneity by making the semi-conductor wafer 6 reciprocate, changing the feed rate of this reciprocating motion, and changing the displacement rate of a polish field according to the location of a polish field, while carrying out the rotation drive of a scouring pad 11 and the semi-conductor wafer 6 with a fixed rate where the thrust per unit area is furthermore held to constant value.
[0115] by the ability leaning and pressing a scouring pad 11 furthermore, various polish area size can be boiled and selected if needed, and it can grind according to the optimal conditions.
[0116] Moreover, corresponding to the reciprocating motion of the semi-conductor wafer toward which it inclined to the scouring pad, by arranging weight to the near side of the main shaft spindle 40, the bias of the thrust by the partial reciprocating motion can be amended, and it can grind to homogeneity.
[0117] (5) it is the gestalt of other operations -- the gestalt of above-mentioned operation -- setting -- control of the feed rate of an X-axis table -- the location of a polish field -- responding -- the variation rate of a polish field, although the case where adjustable [of the rate] was carried out was described This invention may carry out adjustable [of the displacement rate of a polish field] according to the location of a polish field by control of the rotational speed of not only this but the semi-conductor wafer 6, and, thereby, may equalize the amount of polishes in each part of a semi-conductor wafer.
[0118] Moreover, it replaces with the displacement rate of a polish field, adjustable [of the thrust of a scouring pad and the rotational speed of a scouring pad] may be carried out, the amount of polishes in each part of a semi-conductor wafer may be equalized, and it may perform combining these control and the amount of polishes may be equalized.
[0119] Drawing 36 is the functional block diagram showing the configuration of a central-process unit in the case of controlling the rotational speed of this semi-conductor wafer 6. In the configuration shown in this drawing 36 , the rotational speed of the semi-conductor wafer 6 is controlled on the basis of the relative velocity of the semi-conductor wafer 6 in a polish field, and a scouring pad 11.
[0120] That is, the central-process unit 82 detects the location of a polish field in relative-velocity calculation section 82I from the rotation of the X-axis servo motor 65 on the basis of the semi-conductor wafer 6 and each center-of-rotation shaft of a scouring pad 11.
[0121] Relative-velocity calculation section 82I calculates the linear velocity of the semi-conductor wafer 6 in a polish field from the location of this calculated polish field, and the rotational speed of the table shaft servo motor 69. Moreover, relative-velocity calculation section 82I calculates the linear velocity of the scouring pad 11 in a polish field similarly from the location of this calculated polish field, and the rotational speed of the main shaft spindle 40. Furthermore these two calculated linear velocity is added, and this computes relative velocity.
[0122] In subtraction section 82K continuing, the central-process unit 82 generates control data so that the error value of the calculated relative velocity may be calculated and this error value may be set to 0 between the relative velocity held relative-velocity setting section 82J in continuing rate command count section 82L. If it does in this way, it not only equalizes the amount of polishes, but it can reduce the damage of a semi-conductor wafer.
[0123] That is, when the relative velocity calculated by doing in this way is large, as compared with the case where relative velocity is small, minute heights are ground promptly. Moreover, even if it sees the whole semi-conductor wafer, a polish rate increases. However, in the residual stress and internal distortion which remain in the polished surface of a semi-conductor wafer, it increases in connection with relative velocity. Therefore, by setting relative velocity as control standards in this way, and controlling the rotational speed of a semi-conductor wafer, it can combine again, the amount of polishes can be equalized by control of thrust etc., and little polish processing of a damage can be performed.
[0124] moreover -- although the case where adjustable [of the polish rate] was carried out according to the location of a polish field by control of the feed rate of an X-axis table was described in the gestalt of above-mentioned operation -- this invention -- the output voltage of not only this but a load cell -- or the amount of polishes in each part of a semi-conductor wafer may be equalized according to the load current of a main shaft spindle by detecting the load of a scouring pad and carrying out adjustable [of

the polish rate] with this load.
[0125] Although the case where a polish rate was controlled according to a prior setup was described, while this invention measures thickness by the thickness detection sensor 111 not only like this but like the polish equipment 110 shown in drawing 37 and furthermore sets up a polish target on real time from this measurement result in the gestalt of above-mentioned operation, you may make it set up the polish rate corresponding to this polish target.
[0126] Moreover, in the gestalt of above-mentioned operation, although the case where a polish rate was controlled by the load of the main shaft spindle 40 was described, this invention may detect breakage of the blinding of a scouring pad 11, the excess and deficiency of a slurry, and the semi-conductor wafer 6 etc. not only this but by supervising this load collectively.
[0127] Moreover, in the gestalt of above-mentioned operation, although the case where the load or load cell of the main shaft spindle 40 detected the thrust to a scouring pad 11 was described, in the case of the polish equipment which presses a scouring pad 11 to a semi-conductor wafer, this invention may detect direct thrust from the cylinder pressure force not only by this but by the air cylinder. Moreover, thrust may be detected from the driving torque of a Z-axis servo motor.
[0128] Although the case where the ********** reciprocating motion of the semi-conductor wafer was carried out to a scouring pad was furthermore described in the gestalt of above-mentioned operation, this invention may make a semi-conductor wafer reciprocate to the symmetry to a scouring pad by twice as many stroke as the gestalt of the operation not only this but above-mentioned. In addition, if it does in this way, arrangement of a dead weight is also omissible.
[0129] Moreover, although the case where it arranged to one place which fixed the dead weight was described, this invention carries out the variation rate of the location of a dead weight with the reciprocating motion of not only this but a semi-conductor wafer, and you may make it the thrust per unit area always become homogeneity in the gestalt of above-mentioned operation.
[0130] Furthermore, although the case where a semi-conductor wafer was ground in an integrated-circuit production process in the gestalt of above-mentioned operation was described, this invention can be widely applied, when grinding a lens etc. in the production process of not only this but an optic.
[0131]
[Effect of the Invention] In case the sequential variation rate of the polish field is carried out on a processing side and a processing side is ground according to this invention as mentioned above, it sets to a polish field. The minute irregularity of the processing side by a circuit pattern etc. can be markedly reduced on a target as compared with the former by carrying out the variation rate of each part of a polished surface to a processing side above a predetermined criteria rate, and carrying out the variation rate of the polish field below at a criteria rate to a processing side.

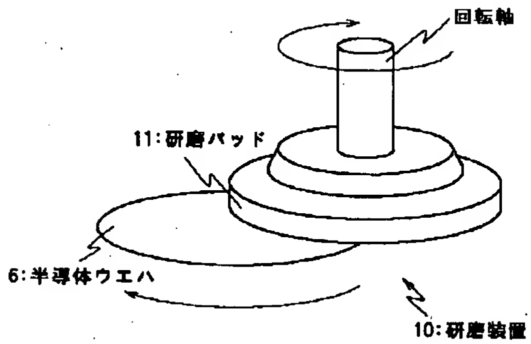
[Translation done.]

Drawing selection | drawing 1



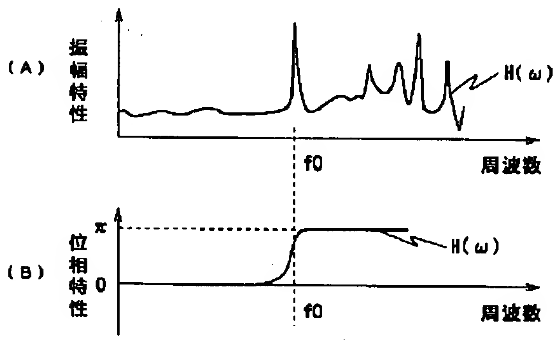
[Translation done.]

Drawing selection drawing 2



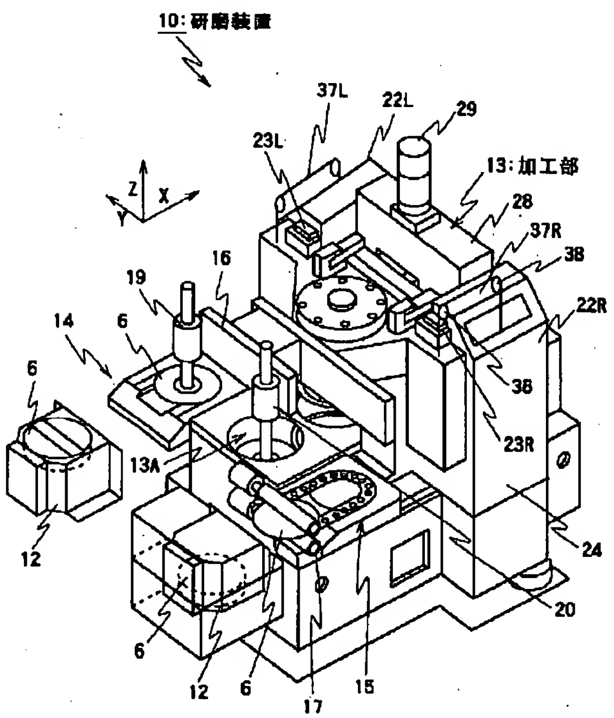
[Translation done.]

Drawing selection | drawing 3



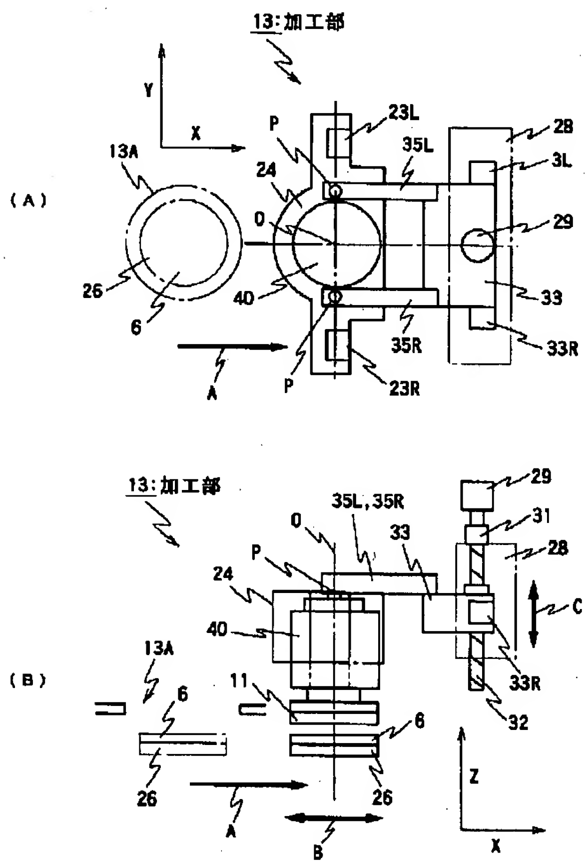
[Translation done.]

Drawing selection | drawing 4



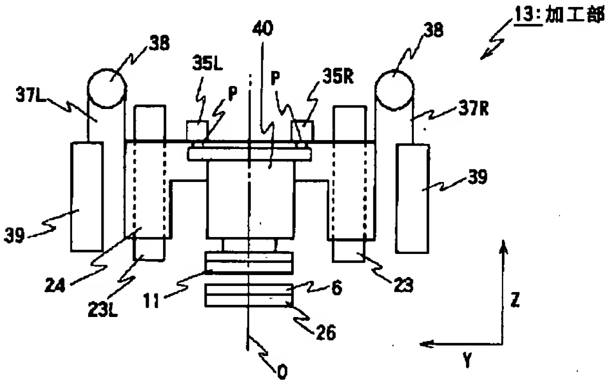
[Translation done.]

Drawing selection drawing 5



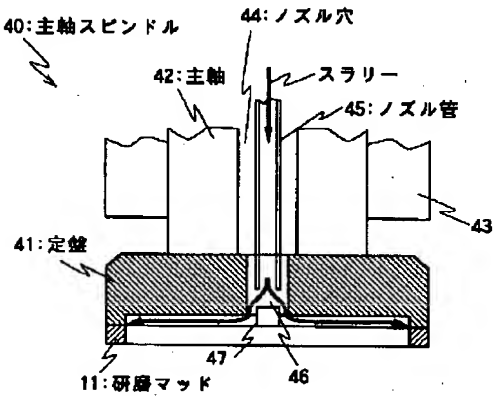
[Translation done.]

Drawing selection | drawing 6



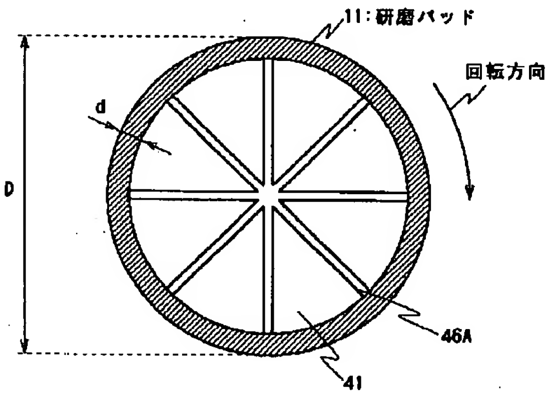
[Translation done.]

Drawing selection | drawing 7



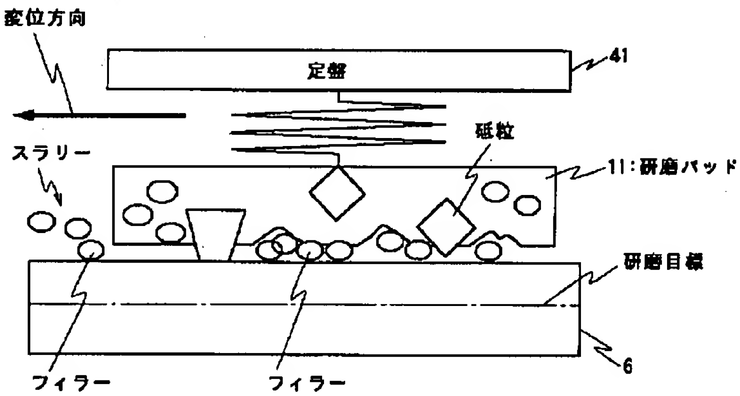
[Translation done.]

Drawing selection | drawing 8



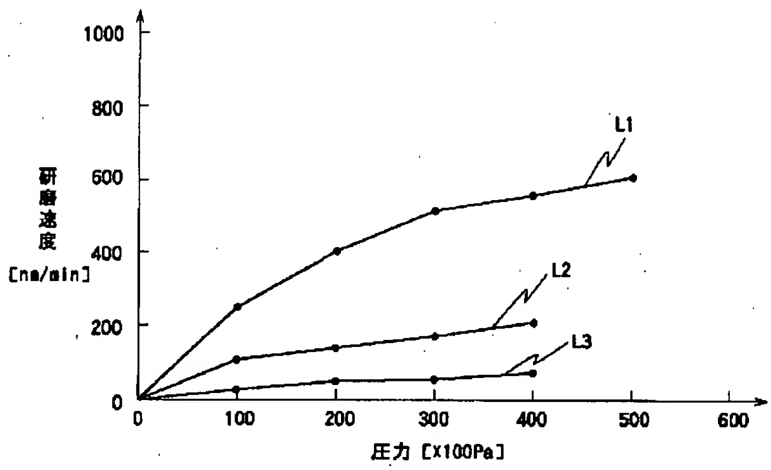
[Translation done.]

Drawing selection | drawing 9



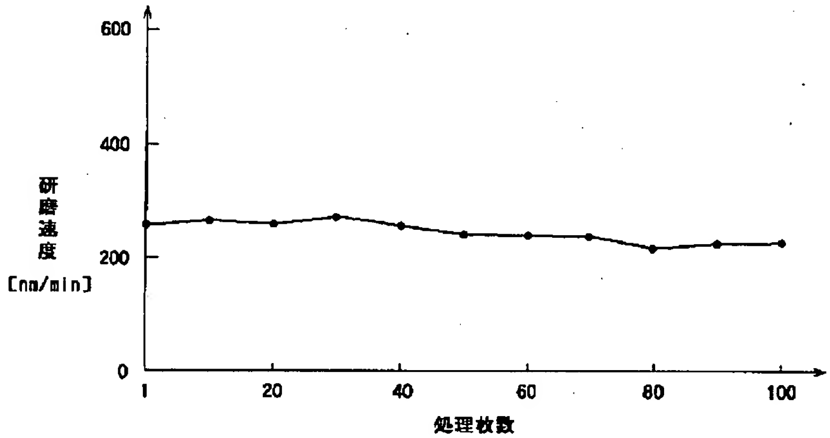
[Translation done.]

Drawing selection | drawing 10



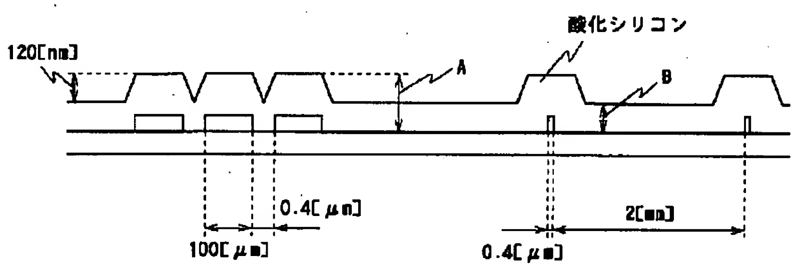
[Translation done.]

Drawing selection | drawing 11



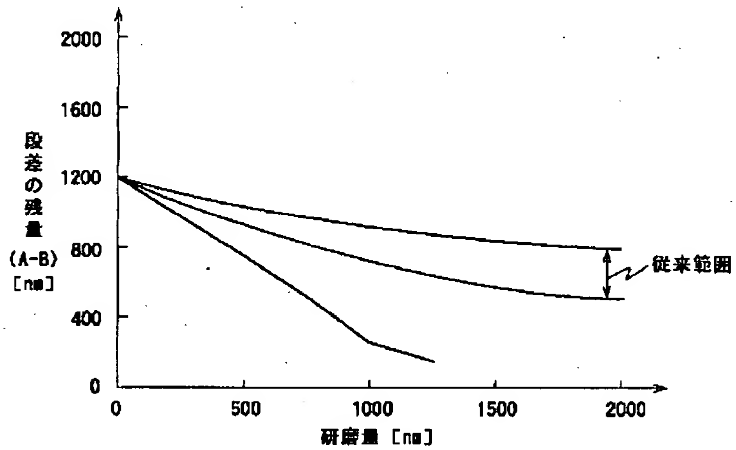
[Translation done.]

Drawing selection | drawing 12



[Translation done.]

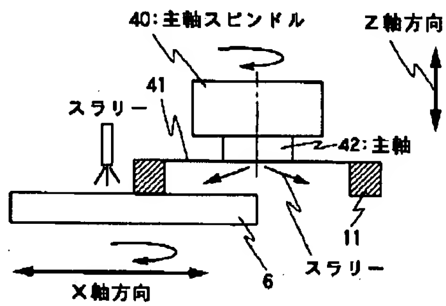
Drawing selection | drawing 13



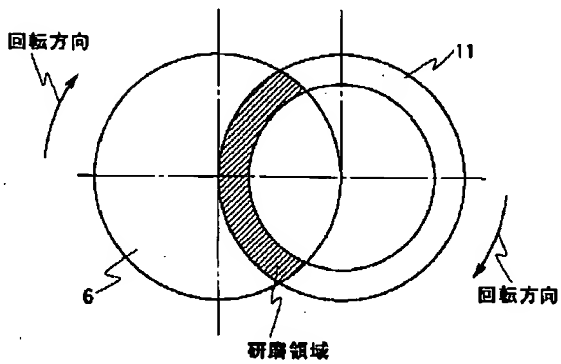
[Translation done.]

Drawing selection | drawing 14

(A)

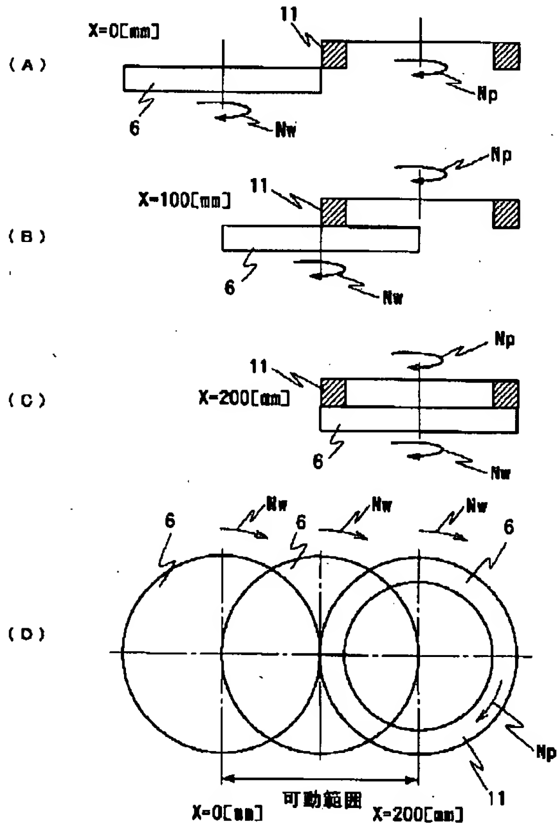


(B)



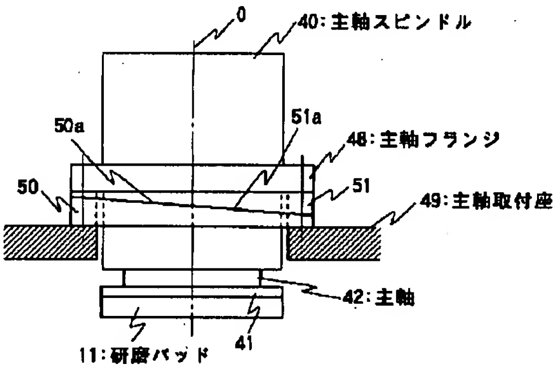
[Translation done.]

Drawing selection | drawing 15



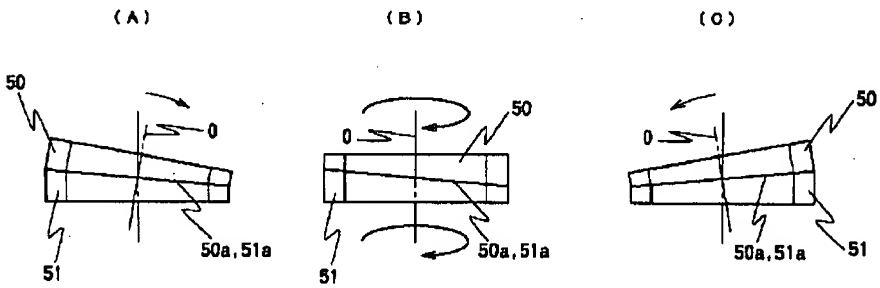
[Translation done.]

Drawing selection | drawing 16



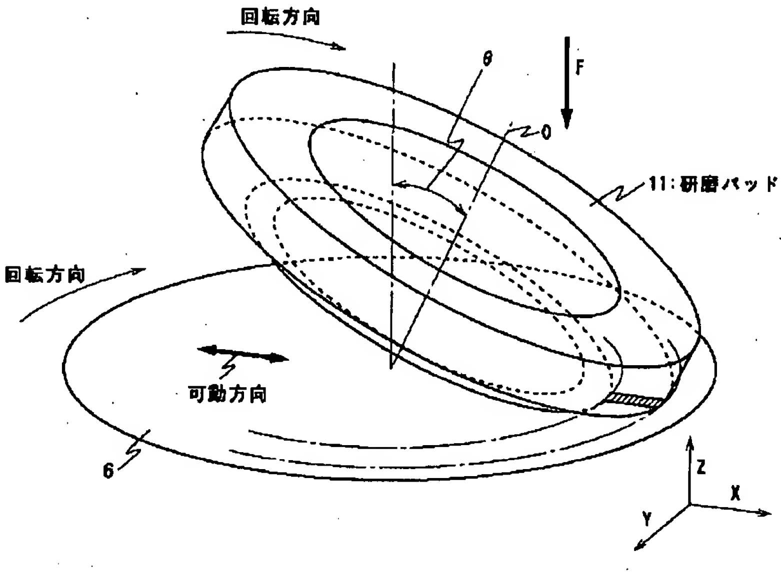
[Translation done.]

Drawing selection | drawing 17



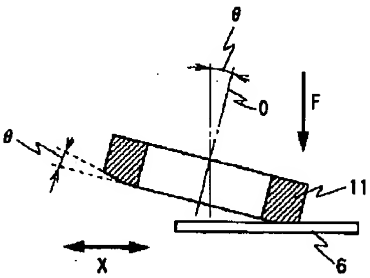
[Translation done.]

Drawing selection | drawing 18



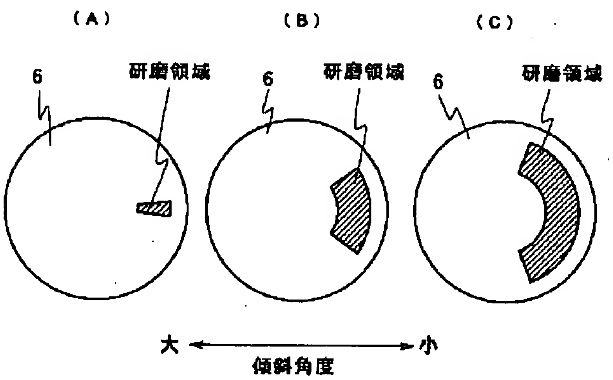
[Translation done.]

Drawing selection | drawing 19



[Translation done.]

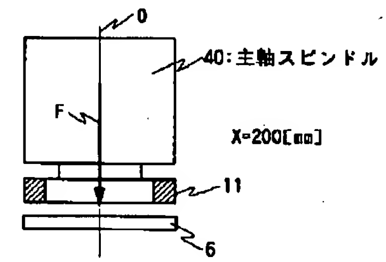
Drawing selection drawing 20



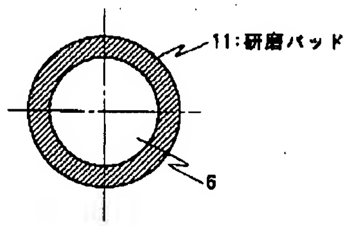
[Translation done.]

Drawing selection | drawing 21

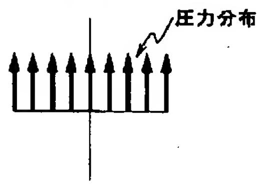
(A)



(B)



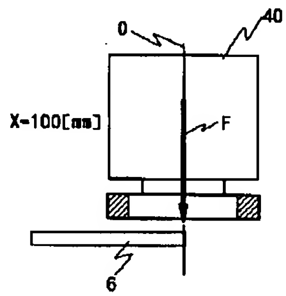
(C)



[Translation done.]

Drawing selection drawing 22

(A)



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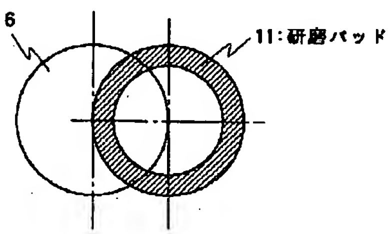

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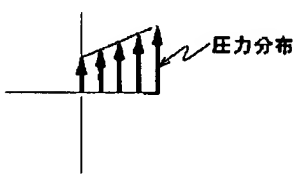
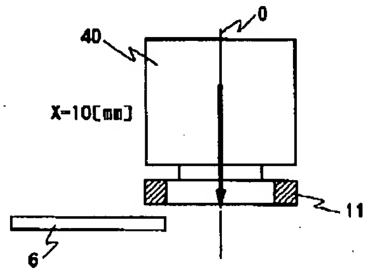


[Translation done.]

Drawing selection | drawing 23

(A)



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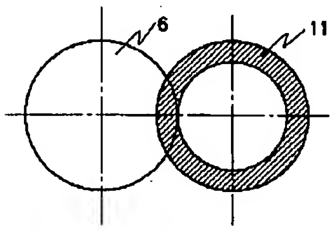

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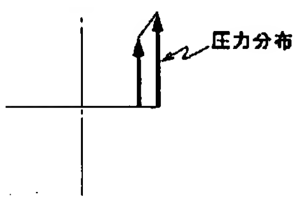
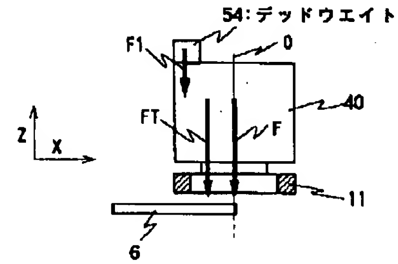


[Translation done.]

Drawing selection | drawing 24

(A)



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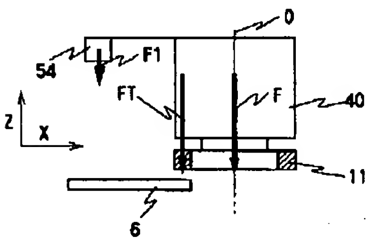

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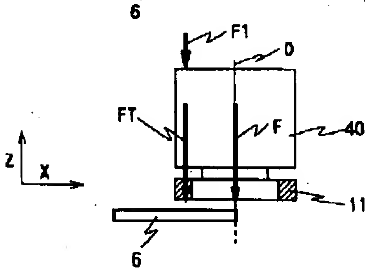
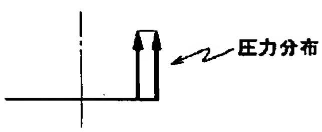
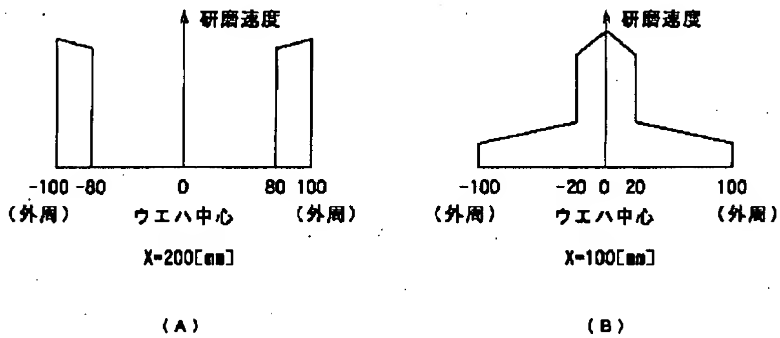


(D)



[Translation done.]

Drawing selection | drawing 25



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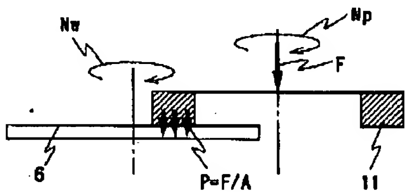
Drawing selection | drawing 26

(A)



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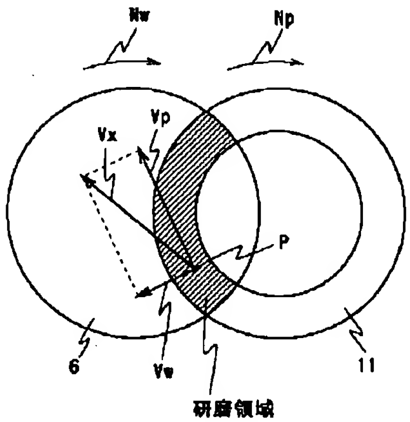
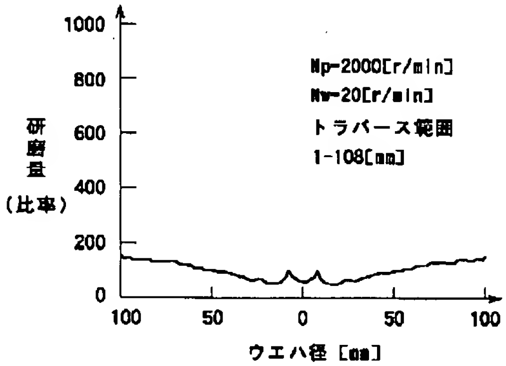


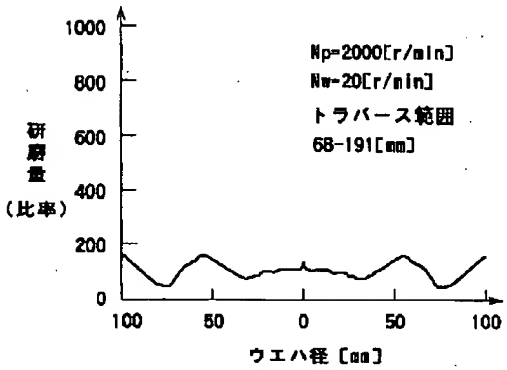
[Translation done.]

Drawing selection | drawing 27

(A)

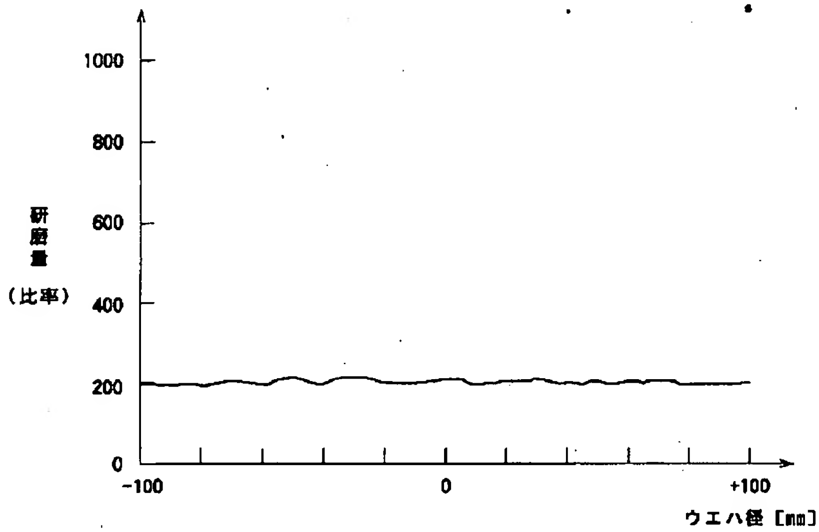


(B)



[Translation done.]

Drawing selection drawing 28



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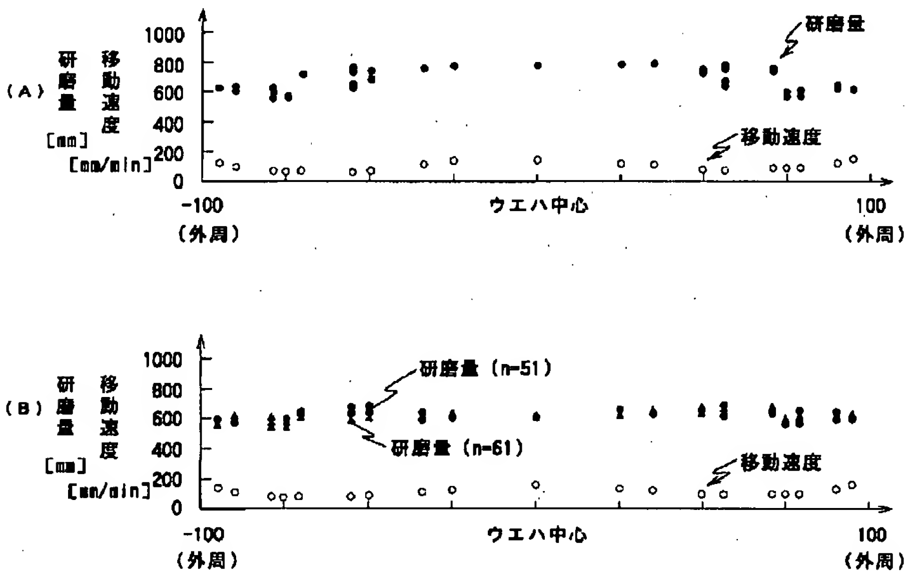
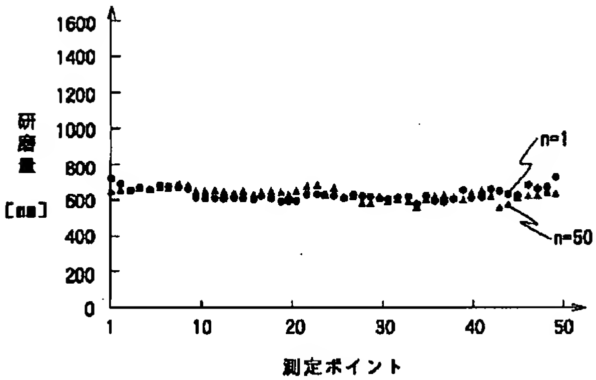
Drawing selection | drawing 29



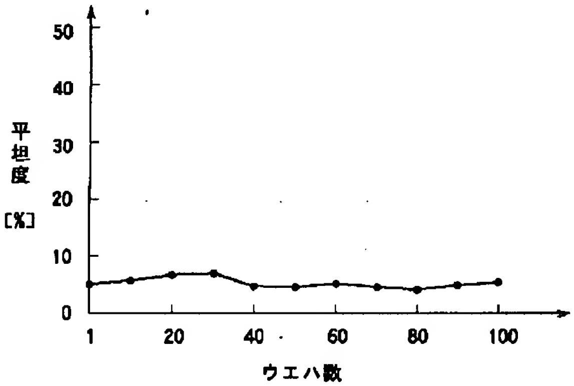
[Translation done.]

Drawing selection | drawing 30



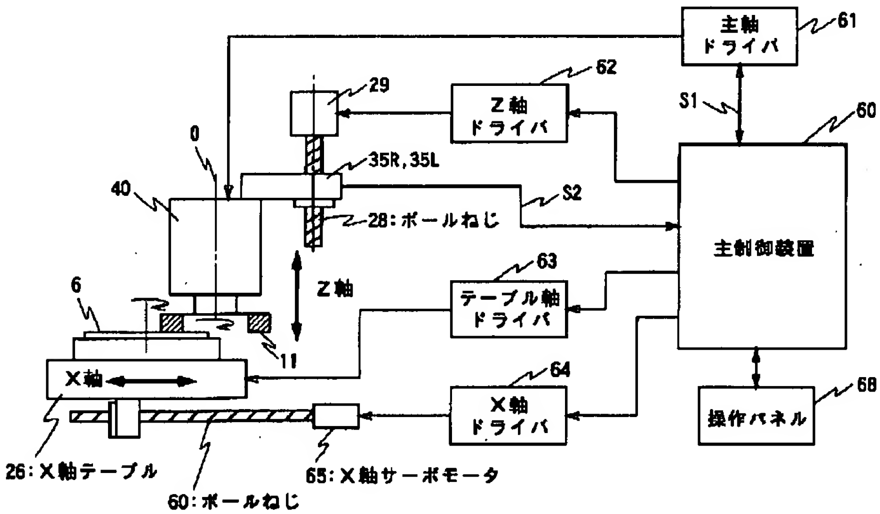
[Translation done.]

Drawing selection | drawing 31



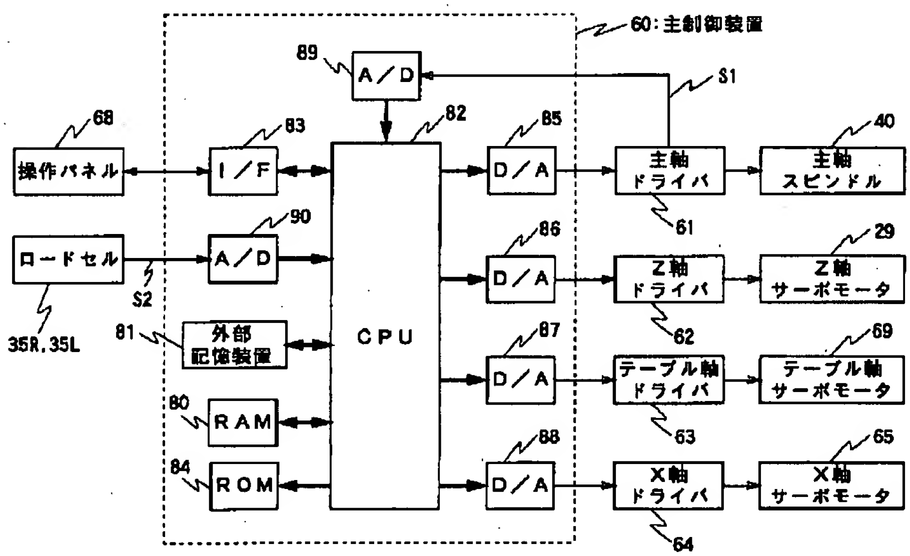
[Translation done.]

Drawing selection | drawing 32



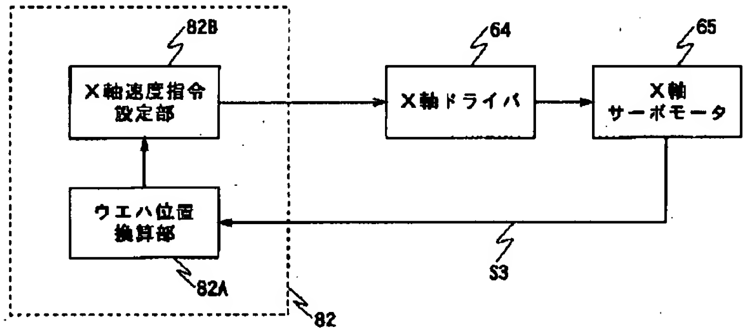
[Translation done.]

Drawing selection drawing 33



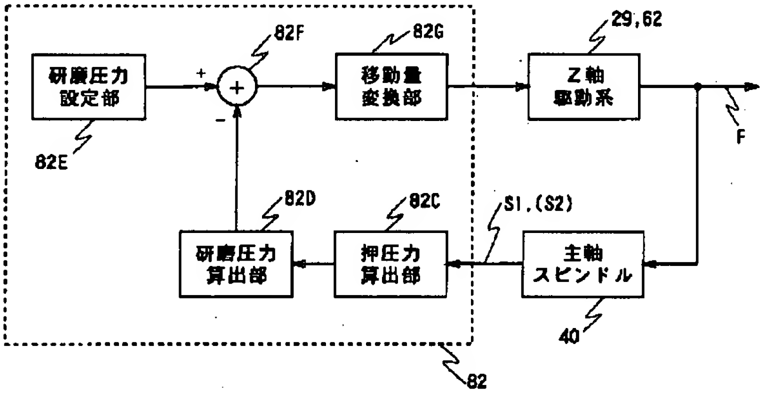
[Translation done.]

Drawing selection | drawing 34



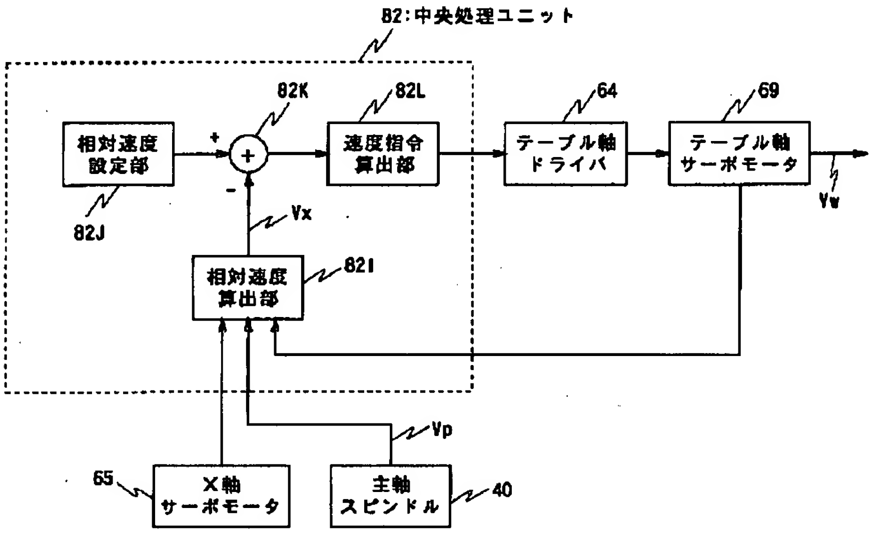
[Translation done.]

Drawing selection | drawing 35



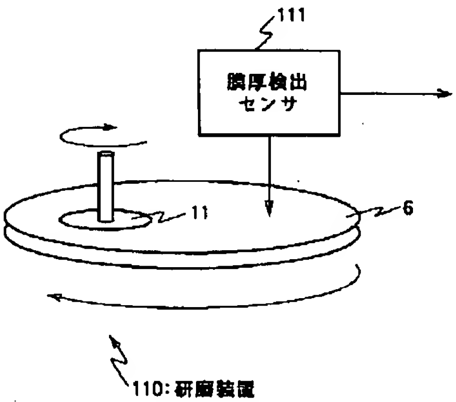
[Translation done.]

Drawing selection | drawing 36



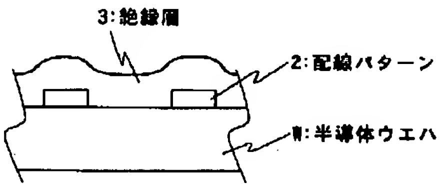
[Translation done.]

Drawing selection | drawing 37



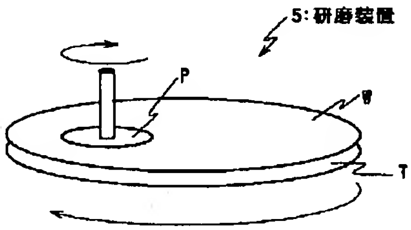
[Translation done.]

Drawing selection drawing 38



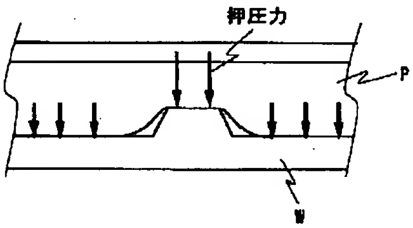
[Translation done.]

Drawing selection | drawing 39



[Translation done.]

Drawing selection drawing 40



[Translation done.]

* NOTICES *

JPO and INPIT are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] In the polish equipment which the processing side for processing is made to carry out the sequential variation rate of the polish field where the polished surface of abrasives comes to contact on said processing side, and grinds said processing side Polish equipment characterized by having the 1st mechanical component to which the variation rate of each part of said polished surface is carried out to said processing side above a predetermined criteria rate, and the 2nd mechanical component which carries out the variation rate of said polish field below at said criteria rate on said processing side in said polish field.
[Claim 2] Said criteria rate becomes at the rate corresponding to the resonance frequency of the base of the mechanical transmission function of the between said abrasives and for [said] processing. Said 1st mechanical component By setting up the displacement rate of said polished surface so that the frequency of the stress which the heights or the crevice of said processing side gives to said polished surface may become more than said resonance frequency The variation rate of each part of said polished surface is carried out to said processing side above said criteria rate. Said 2nd mechanical component Polish equipment according to claim 1 characterized by carrying out the variation rate of said polish field below at said criteria rate by setting up a displacement rate so that the frequency of the stress which the wave of said processing side gives to said polished surface may turn into said below resonance frequency.
[Claim 3] Said 1st mechanical component is polish equipment according to claim 1 characterized by carrying out adjustable [of the thrust of said polished surface to said processing side] according to the location of the polish field on said processing side.
[Claim 4] Said 1st mechanical component is polish equipment according to claim 1 characterized by carrying out adjustable [of the rate of the variation rate of said polished surface over said processing side] according to the location of said polish field on said processing side.
[Claim 5] Said 2nd mechanical component is polish equipment according to claim 1 characterized by carrying out adjustable [of the rate of the variation rate of said polish field] according to the location of the polish field on said processing side.
[Claim 6] Said 1st mechanical component is polish equipment according to claim 1 characterized by carrying out adjustable [of the thrust of said polished surface to said processing side] according to the load at the time of driving said abrasives.
[Claim 7] Said 1st mechanical component is polish equipment according to claim 1 characterized by carrying out adjustable [of the rate of the variation rate of said polished surface over said processing side] according to the load at the time of driving said abrasives.
[Claim 8] Said 2nd mechanical component is polish equipment according to claim 1 characterized by carrying out adjustable [of the rate of the variation rate of said polish field] according to the load at the time of driving said abrasives.
[Claim 9] Said 1st mechanical component is polish equipment according to claim 1 characterized by carrying out adjustable [of the thrust of said polished surface to said processing side] according to the

detection result of the thickness of said processing side by the thickness detection means.
[Claim 10] Said 1st mechanical component is polish equipment according to claim 1 characterized by carrying out adjustable [of the rate of the variation rate of said polished surface over said processing side] according to the detection result of the thickness of said processing side by the thickness detection means.
[Claim 11] Said 2nd mechanical component is polish equipment according to claim 1 characterized by carrying out adjustable [of the rate of the variation rate of said polish field] according to the detection result of the thickness of said processing side by the thickness detection means.
[Claim 12] Said 2nd mechanical component is polish equipment according to claim 5 characterized by carrying out adjustable [of the rate of the variation rate of said polish field] by carrying out the rotation drive of said candidate for polish, carrying out the variation rate of said polish field, and carrying out adjustable [of the rotational speed for / said / polish].
[Claim 13] Said 2nd mechanical component is polish equipment according to claim 8 characterized by carrying out adjustable [of the rate of the variation rate of said polish field] by carrying out the rotation drive of said candidate for polish, carrying out the variation rate of said polish field, and carrying out adjustable [of the rotational speed for / said / polish].
[Claim 14] Said 2nd mechanical component is polish equipment according to claim 11 characterized by carrying out adjustable [of the rate of the variation rate of said polish field] by carrying out the rotation drive of said candidate for polish, carrying out the variation rate of said polish field, and carrying out adjustable [of the rotational speed for / said / polish].
[Claim 15] Said 2nd mechanical component by moving said candidate for polish to said abrasives By carrying out the variation rate of said polish field, or moving said abrasives to said candidate for polish Polish equipment according to claim 5 characterized by carrying out adjustable [of the rate of the variation rate of said polish field] by carrying out the variation rate of said polish field, and carrying out adjustable [of the rate of migration of said abrasives for / said / processing].
[Claim 16] Said 2nd mechanical component by moving said candidate for polish to said abrasives By carrying out the variation rate of said polish field, or moving said abrasives to said candidate for polish Polish equipment according to claim 8 characterized by carrying out adjustable [of the rate of the variation rate of said polish field] by carrying out the variation rate of said polish field, and carrying out adjustable [of the rate of migration of said abrasives for / said / processing].
[Claim 17] Said 2nd mechanical component by moving said candidate for polish to said abrasives By carrying out the variation rate of said polish field, or moving said abrasives to said candidate for polish Polish equipment according to claim 11 characterized by carrying out adjustable [of the rate of the variation rate of said polish field] by carrying out the variation rate of said polish field, and carrying out adjustable [of the rate of migration of said abrasives for / said / processing].
[Claim 18] Said 1st mechanical component is polish equipment according to claim 1 characterized by having a thrust detection means by which the polished surface of said abrasives presses said processing side, and the control means which controls said thrust.
[Claim 19] Said 1st mechanical component is polish equipment according to claim 1 with which said polish field is set up and the inclination of the shaft of said rotation drive to said processing side is characterized by being held possible [adjustment] by carrying out the rotation drive of said abrasives, and contacting said abrasives to said processing side partially.
[Claim 20] Said 1st mechanical component is polish equipment according to claim 1 characterized by having an amendment means to set up said polish field and to amend the bias of said polish field to said revolving shaft by carrying out the rotation drive of said abrasives, and contacting said abrasives to said processing side partially.
[Claim 21] Polish equipment according to claim 1 characterized by supplying a loose grain to said polish field.
[Claim 22] Polish equipment according to claim 1 characterized by particle size supplying the loose grain of 1 / 6 - 1/3 to said polish field to the bonded abrasive contained in said polish member.
[Claim 23] Abrasives characterized by setting up a degree of hardness so that it may be partially pressed

by the processing side for processing to rotate where a rotation drive is carried out with a predetermined revolving shaft, and the basic resonance frequency of the mechanical transmission function to said candidate for processing may turn into a frequency of 10 times or more of the rotational frequency for [said] processing in the abrasives which grind said processing side.
[Claim 24] Abrasives according to claim 23 characterized by having carried out distributed mixing and forming bonded abrasive in the resin which has a detailed hole.
[Claim 25] The polish approach characterized by forming in the processing side for processing the polish field where the polished surface of abrasives comes to contact, carrying out the variation rate of each part of said polished surface to said processing side in said polish field above a predetermined criteria rate, and carrying out the variation rate of said polish field below at said criteria rate on said processing side.
[Claim 26] Said criteria rate becomes at the rate corresponding to the resonance frequency of the base of the mechanical transmission function of the between said abrasives and for [said] processing. By setting up the displacement rate of said polished surface so that the frequency of the stress which the heights or the crevice of said processing side gives to said polished surface may become more than said resonance frequency By carrying out the variation rate of each part of said polished surface to said processing side above said criteria rate, and setting up a displacement rate so that the frequency of the stress which the wave of said processing side gives to said polished surface may turn into said below resonance frequency The polish approach according to claim 25 characterized by carrying out the variation rate of said polish field below at said criteria rate.
[Claim 27] The polish approach according to claim 26 characterized by carrying out distributed mixing of the bonded abrasive, forming said abrasives in the resin which has a detailed hole, and supplying a loose grain to said polish field at it.
[Claim 28] The polish approach according to claim 27 characterized by setting the particle size of said loose grain as 1 / 6 - 1/3 to the particle size of said bonded abrasive.
[Claim 29] The polish approach according to claim 25 characterized by carrying out adjustable [of the thrust of said polished surface to said processing side] according to the location of the polish field on said processing side.
[Claim 30] The polish approach according to claim 25 characterized by carrying out adjustable [of the rate of the variation rate of said polished surface over said processing side] according to the location of said polish field on said processing side.
[Claim 31] The polish approach according to claim 25 characterized by carrying out adjustable [of the rate of the variation rate of said polish field] according to the location of the polish field on said processing side.
[Claim 32] The polish approach according to claim 25 characterized by carrying out adjustable [of the thrust of said polished surface to said processing side] according to the load at the time of driving said abrasives.
[Claim 33] The polish approach according to claim 25 characterized by carrying out adjustable [of the rate of the variation rate of said polished surface over said processing side] according to the load at the time of driving said abrasives.
[Claim 34] Said 2nd mechanical component is the polish approach according to claim 25 characterized by carrying out adjustable [of the rate of the variation rate of said polish field] according to the load at the time of driving said abrasives.
[Claim 35] The polish approach according to claim 25 characterized by carrying out adjustable [of the thrust of said polished surface to said processing side] according to the detection result of the thickness of said processing side by the thickness detection means.
[Claim 36] The polish approach according to claim 25 characterized by carrying out adjustable [of the rate of the variation rate of said polished surface over said processing side] according to the detection result of the thickness of said processing side by the thickness detection means.
[Claim 37] The polish approach according to claim 25 characterized by carrying out adjustable [of the rate of the variation rate of said polish field] according to the detection result of the thickness of said

processing side by the thickness detection means.

[Translation done.]